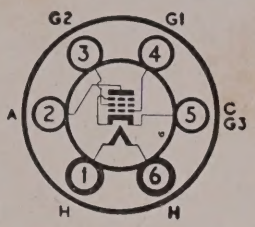
RADIO and ELECTRONICS

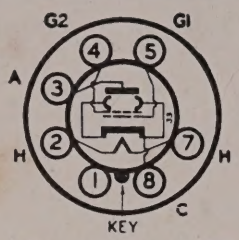
TELEVISION - COMMUNICATIONS - SERVICE - SOUND

DECEMBER 1st, 1953 VOL. 8, NO. 10

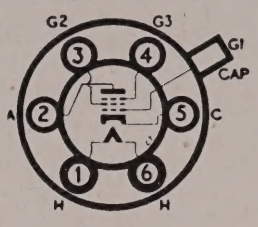
Two rare valves - the answer lies in using types to BRIMARIZE



Type 41



Types 6K6G, 6V6GT



Type 89

CHARACTERISTICS

	TYPE 89	TYPES 41, 6K6G	TYPE 6V6GT
Heater Voltage	6.3	6.3	6.3 volts
Heater Current	0.4	0.4	0.45 amp.
Anode Voltage	250	250	250 volts
Anode Current	32	32	32 mA
Grid Bias	−25	−18	−15 volts
Cathode Resistor	680	470	390 ohms
Optimum Load	7000	7500	7500 ohms
Power Output	3.4	3.4	3 3 watts

Type 89 is a low-consumption output pentode used mainly in car radio receivers. It may be replaced most conveniently by type 41 or, with change of socket, by 6K6G. Type 6V6GT may also be employed together with change of socket and bias resistor.

CHANGE VALVE		CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY	PERFORMANCE CHANGE
FROM	TO	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET		
Type 89	Type 41	U.X. 6 pin	No Change	Pin 1 ,, 2 ,, 3 ,, 4 ,, 5 ,, 6 Top Cap	Pin 1 ,, 2 ,, 3 Disconnect Pin 5 ,, 6 ,, 4	Change bias resistor if necessary. The correct value for type 41 or 6K6G is 470 ohms 1 watt	NEGLIGIBLE
89	6K6G	U.X. 6 Pin	Int. Octal.	Pin 1 ,, 2 ,, 3 ,, 4 ,, 5 ,, 6 Top Cap	Pin 2 ,, 3 ,, 4 Disconnect Pin 8 ,, 7 ,, 5		
89	6V6GT	U.X. 6 Pin	Int. Octal.	As for Type 6K6GT		Change bias Resistor to 390 ohms 1 watt .See NOTE.	HIGHER SENSITIVITY

NOTE.—In 12-volt receivers where the heater of the 89 is connected in series with one of the other valves a balancing resistor may be required in the heater circuit.

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Radio and Electronics

Our cover picture this month shows B.B.C. television cameras in operation at the 1948 Olympic Games held in Britain.

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The N.Z. Radio Traders' Federation.

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CORRESPONDENCE
All correspondence and contributions should be addressed to:

The Editor,
"Radio and Electronics,"
P.O. Box 8022,
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OFFICES AND LABORATORY:
Radio and Electronics (N.Z.), Ltd.,
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Greetings for Christmas and the New Year

NEW ZEALAND RADIO AND TELEVISION MANUFACTURERS' FEDERATION

To All Members of the New Zealand Radio Industry.

This time last year I was optimistic enough to predict a profitable 1953 for all of us. That prediction has come true, and, although competition has been intense, there has been no diminution to the range, quality, or quantity of our output.

We can therefore approach the Christmas of 1953 with a feeling of satisfaction and pleasure in something achieved, and to look into the New Year with high hopes for another prosperous year.

Today, as I write this, many hundreds of people in Wellington are actually seeing practical and high-quality public demonstrations of television transmissions from equipment designed and built in New Zealand by one of our own members.

In wishing you all a very Merry Christmas and Happy New Year, I cannot help feeling that coming events are already casting their shadows before them.

R. SLADE, President.

N.Z. RADIO TRADERS' FEDERATION

Through the courtesy of "Radio and Electronics," may I extend, on behalf of the New Zealand Radio Traders' Federation, cordial seasonal greetings to all employers and employees engaged in the radio and electronics industry. I hope that the industry will continue to expand and that 1954 will be a happy and prosperous year for all.

N. SOUPER, President.

WELLINGTON RADIO TRADERS' ASSOCIATION

As Christmas, 1953, approaches, I would like, on behalf of the Executive and myself, to extend the Season's Greetings to our many friends in the Radio Industry; 1954 approaches with the prospects of buoyant trading, and we wish you all a very prosperous New Year.

N. J. HALLETT, President.

N.Z. RADIO-TELEVISION AND ELECTRICAL TRADERS' ASSOCIATION

Another 12 months have passed, in which time the Radio Industry has steadily gone forward, keeping up with the march of progress. I, personally, feel that this vital industry is on a sounder footing in this country than ever before, and it is gratifying indeed to know that the present buoyant state of the radio trade has been helped considerably by the mutual co-operation and goodwill existing among all members of the industry. With this common understanding which exists at the present time, I consider that the foundations of our industry are being strengthened daily.

With this thought in mind, I wish to extend my very best wishes, not only to members of our Association, but to all those engaged in the Radio Industry, and sincerely hope and trust that the forthcoming year will bring you health and happiness and sound trading conditions.

C. R. PEOPLES, President.

A STEP FORWARD

Marking the commencement of another epoch in the communications history of New Zealand, 9th November saw the opening of the Post and Telegraph Department's new transmitting station at Himatangi, near Foxton. With radio communication so commonplace these days, such an announcement scarcely stirs the imagination even of the man-in-the-street, let alone that of technical people, but the opening of this particular station is certainly a landmark. Up to the present, New Zealand has depended on the co-operation of the Australian Post Office for its radio-telephone traffic to Great Britain. Admittedly, this co-operation was willingly given, but it is usually desirable in communications work to have the most direct route possible for one's traffic, especially if the indirect route means that the channel comes under the control of someone else, no matter how benevolent. Consequently, the Post and Telegraph Department has always looked forward to the time when it could pass New Zealand's radio-telephone traffic to the United Kingdom directly over its own circuits.

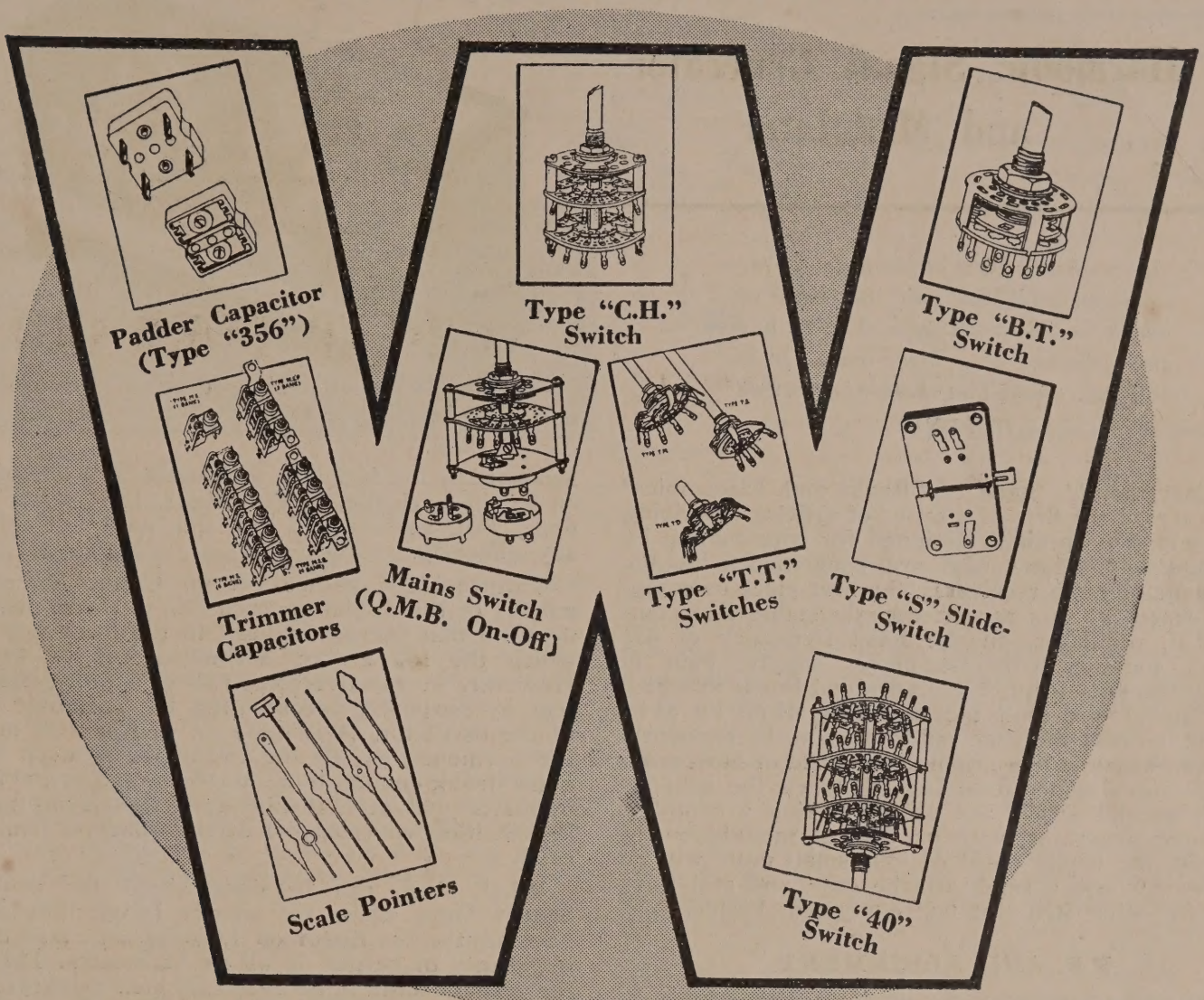
Those who were privileged to attend the opening ceremony, and later to inspect the equipment, were enormously impressed with the scale of the undertaking and with the manner of its realization. Full use has been made of the most modern techniques. For instance, Himatangi is linked to Wellington by a 24-channel V.H.F. link, which, in addition to providing twelve channels for the use of the transmitting station, will ultimately provide twelve toll channels out of Wellington in addition to those in use at present. Undoubtedly the use of this V.H.F. link must be much more economical than the running of an underground cable. The link covers the 80-mile journey in two hops—from a station in Wellington to Colonial Knob, on the hills above Tawa Flat, and from there to Himatangi. The voice quality is amazingly good. In fact, no one could guess that a radio link was involved at all.

The main transmitter for the U.K. radio-telephone channel puts out 40 kilowatts on any frequency between 4 and 27.5 mc/sec. Should this be thought rather small power for the purpose, it is pointed out that this is single-sideband transmission, giving it an effective power of several times that amount, compared with an ordinary AM transmitter of the same carrier power. The station also includes lower-powered transmitters for the circuits to U.S.A. by radio-telephone and to U.K. by telegraphy. The latter

(Concluded on page 48.)

WALTER INSTRUMENTS

SWITCHES and TRIMMERS



WALTER INSTRUMENTS, well known to the radio communications and electronic industries, represent the highest standard of British workmanship and dependability.

TYPE "40" SWITCH: Most versatile switch available, providing for all radio-frequency and high-frequency switching.

TYPE "C.H." SWITCH: Similar in construction to the popular Type "40," but slightly smaller in shape.

TYPE "B.T." SWITCH: A midget switch for use where only limited space is available and simple switching will suffice.

TYPE "S" SLIDE SWITCH: A flat switch, operated by slide action, and biased to one position, either "on" or "off" as required.

TYPE "T.T." SWITCHES: With a contact technique similar to the "Type 40", these models are unsurpassed where simple switching will suffice, but where reliability of operation is essential.

MAINS SWITCH (Q.M.B. ON-OFF): A useful switch for switching on and off mains current to low-current electrical apparatus such as a radio receiver; robust construction.

TRIMMER CAPACITORS (M.S. SERIES): Carefully designed to maintain steady capacity with freedom from "drift" throughout normal temperature changes and conditions of reasonable mechanical vibration.

PADDER CAPACITOR (Type "356"): A popular component designed to be assembled into modern $1\frac{3}{8}$ in. square I.F. Cans and available in a wide range of capacities.

SCALE POINTERS: .Pointers to provide station or wavelength indication are available in a variety of designs. Designs to suit individual requirements also supplied.

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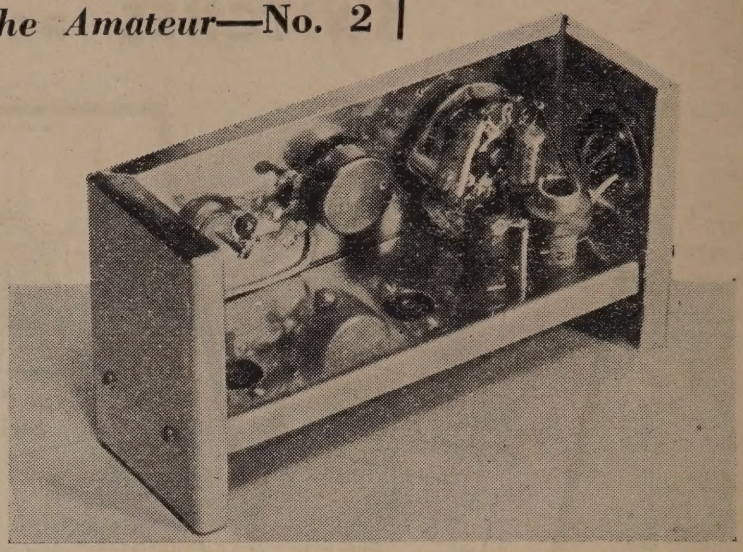
Test Equipment for the Amateur—**No. 2**

A Harmonic Signal Generator and Modulator



Above-chassis view of the inside of the oscillator-multiplier unit, the circuit of which is found on page 6. The box and chassis are home-made from 18-gauge aluminium sheet, as described on page 5.

In last month's issue of "Radio and Electronics" we presented the first of a series of articles describing test equipment specially designed for construction by amateurs and others who are concerned with the alignment of radio receivers. The first piece of equipment described was an exceedingly stable and compact I.F. oscillator, on the fixed frequency of 455 kc/sec., together with its power supply, built in equally compact form. The cast-metal boxes in which these units were built measure only 4¾ in. by 3½ in. by 2 in., so that the gear can be seen to be eminently portable, which is more than can be said of most commercial signal-generators. Indeed, when the subjects of this second article are added, making a complete alignment generator, with or without modulation, as required, the whole outfit of four small units will go quite easily into a small attache case, and still leave room for other items of test equipment besides!

R.F. AND ALIGNMENT

Those who have read the previous article have no doubt wondered how we proposed to provide them with a small device which would fulfil the functions of a multi-band signal generator. The answer is really very simple. Instead of having a generator which can put out a signal on one frequency at a time, the frequency being adjustable, we use a generator which will give forth a large number of accurately known frequencies, **all at once.** This scheme has much to recommend it. It means that the signal generator needs no calibrated dial, no multi-range switching, and no calibrated attenuator or complicated shielding. It means, too, that, like the I.F. generator, the basic signal source can be a highly stable fixed-frequency oscillator.

It might be wondered how an oscillator is made to give out a large number of signals simultaneously, and how such a source can be used in aligning a receiver. Both these questions are very simply answered.

First of all, suppose our oscillator is on a frequency of 100 kc/sec. It will not have a perfectly pure output waveform, which is only another way of saying that its output contains harmonics. These will be at 200, 300, 400, etc., cycles per second, and each harmonic will appear on a receiver as a signal, just as if it was made by its own individual oscillator. The only thing about these signals that might conceivably be a trifle awkward is the fact that we cannot turn one of them on to the exclusion of the others. It is either all or none. But, as we shall see, this need not cause us any difficulty.

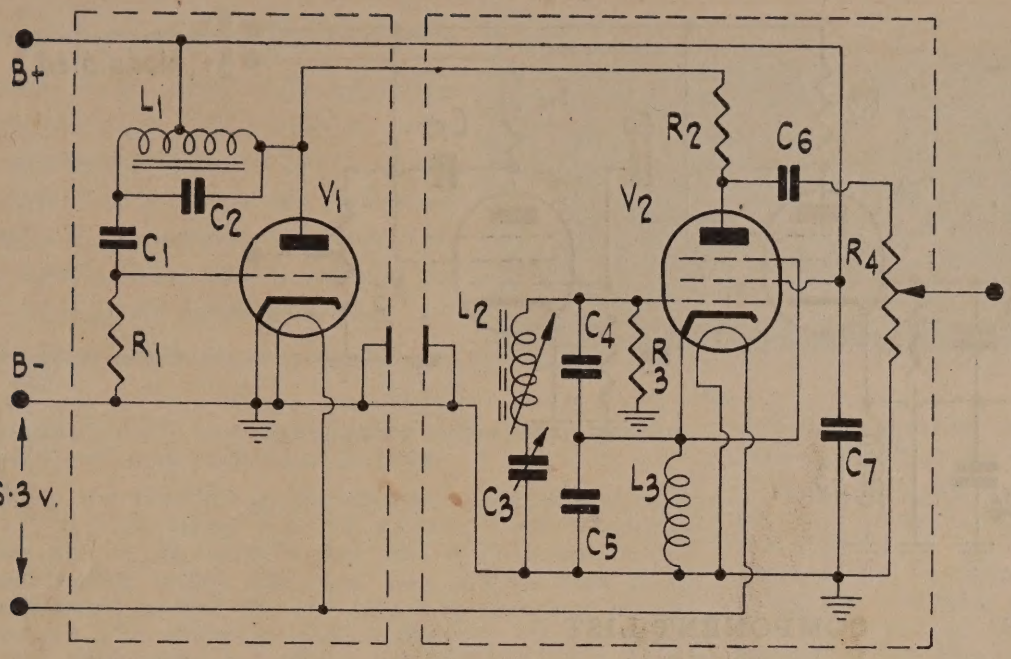
Unfortunately, as we get up to the higher harmonics of the oscillator, each one is weaker than the next, so that there is a limit to the frequency up to which the 100 kc/sec. harmonics can be detected. However, we can overcome this to a considerable extent by purposely accentuating the harmonic output of the oscillator. It is quite an easy matter to make the harmonics up to the twentieth, or even higher, quite strong enough to be usable, so that a 100 kc/sec. oscillator will at that rate give signals up to 2,000 kc/sec., thus covering the whole broadcast band quite easily.

What, then, can be done about the shortwave bands? Once again, the answer is not difficult. We have another oscillator on 1,000 kc/sec., also delivering plenty of output on all its harmonics. This time, the signals come in at 1, 2, 3, 4, etc., megacycles per second, up to about 20 mc/sec., so that the range from broadcast frequencies up to the highest usually used in allwave receivers can be covered with only these two oscillation frequencies.

PRACTICAL REALIZATION

In practice, the signal generator we have designed to use the principles just outlined uses only two valves. One of these is the oscillator, and by simple switching it can be made to operate on either 100 or 1,000 kc/sec. The second valve is a harmonic generator, whose job is simply to accentuate the harmonics of the oscillator. It looks like nothing more complicated than a resistance-capacity-coupled amplefier with a very small load resistor. The output is taken from the plate through a blocking condenser and via a potentiometer, which gives some measure of control over the output voltage.

The oscillator is a Clapp circuit, like the I.F. oscillator, and has two tuned circuits, which by a simple arrangement can be brought into action at will. Since the same harmonic amplifier circuit is used in both cases, no output switching is required. As before, the oscillator is extremely stable—much more so than can be expected from a commercial signal generator, provided it is well constructed. It is a simple matter to have these fixed-frequency oscillators calibrated once



COMPONENT LIST

L_1, 3-watt universal output transformer, secondaries unused.

C_1, 0.02 μf.

C_2, 0.02 μf.

R_1, 100k.

V_1, 6C4.

Above: Circuit diagram of the modulator, showing how the H.T. feeds to the I.F. oscillator (described in the last issue) are arranged so that when the latter is plugged into the modulator socket, the oscillator screen receives unmodulated H.T., but the plate is modulated by the audio oscillator. The modulator itself comprises only the portion of the diagram inside the left-hand dotted enclosure. The remainder will be recognized as the I.F. oscillator.

and for all, and one can always be sure of the correctness of circuits, for example, that when both have been adjusted to frequency, it is possible to tune a receiver to 1,000 kc/sec., pick up the 1,000 kc/sec. oscillator, and then switch over to the 100 kc/sec. oscillator, finding its tenth harmonic perfectly tuned in. And if a second oscillator is used to give a beat note, or zero beat, with the signals from the oscillators, it is possible to observe that when the switch is turned back again to 1,000 kc/sec., this frequency is still accurately the same, even to a few cycles per second. This is real stability, as we think readers will agree, such as can hardly be obtained in any other way, except in the most expensive commercial equipment.

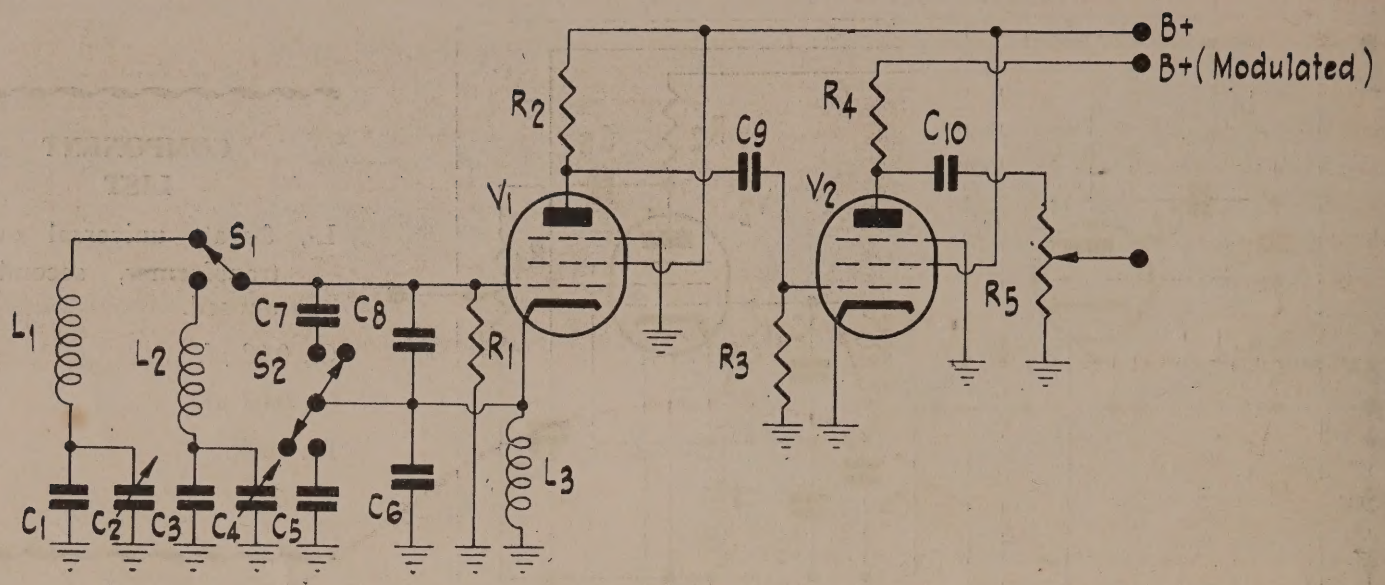
MODULATION

Most users will want to have the signals both from the 455 kc/sec. and from the 1,000 and 100 kc/sec. oscillators modulated with an audio note in order to make alignment easier. The oscillators themselves, of course, are unmodulated, and so, in addition to the three oscillators, we have built a little modulator unit. We should point out that the same power supply as was described in the last article will power all three units. One simply plugs in the units required, and the power supply does the rest. It is therefore possible to have either modulated or unmodulated signals at will. The drill is to plug the modulator box into the power supply, which then automatically applies power to it and starts the audio oscillator functioning. Then, if the R.F. oscillators are to be used, they in turn are plugged in to the socket provided on the modulator box. This places the three units in series, as it were. If the same oscillator is needed, but not modulated, the modulator is simply unplugged, and the oscillator is plugged directly into the power supply unit. If the I.F. oscillator is needed, either modulated or unmodulated, the appropriate set-up can be made with it, too.

PHYSICAL CONSTRUCTION

Unfortunately, it was found impossible to put the R.F. oscillator and harmonic amplifier into one of the small cast boxes without cramping things too much, so that an aluminium chassis had to be made specially for it. It consists, as can be seen from the photographs, of a small shelf fitted into a box, made in two three-sided portions. The part which holds the chassis shelf has flanges all round it so that the other three sides can be fitted on with self-tapping screws in the manner of a lid. The inside photograph has been taken with the valves removed so as to show the "works" more clearly. At the right we have the two tuning coils and the range switch above the chassis. In the centre is the output potentiometer and the output socket. The valve nearest the oscillator coils is, of course, the oscillator valve, and the socket for the harmonic amplifier is at the extreme left of the chassis. In the under-chassis view can be seen the two Philips trimmers and the fixed condensers in parallel with them. These trimmers are used for adjusting the oscillator circuits exactly to frequency, after which they remain untouched. The two 0.002 μf. condensers connected respectively between grid and cathode and cathode and ground are connected right at the valve socket, and can be seen in the underneath view, while the 0.01 μf. condensers, which are connected in parallel with them by the range switch in the 100 kc/sec. are above the chassis and are connected to the switch lugs. In the underneath view can be seen the cathode choke, on the opposite side of the oscillator socket from the 0.002 condensers.

The dimensions of the box are 7 in. long, by 2¼ in. deep, by 3¾ in. high. This makes it the same height and depth as the cast boxes in which the other units have been built, but longer, to accommodate the second valve and its circuit.



COMPONENT LIST

L_1, secondary winding from a B/C Ae. or R.F. coil (see text).
L_2, L_3, windings from a 175 kc/sec. I.F. bobbin (see text).
C_1, 250 $\mu\mu$f. mica.
C_2, C_4, 3-30 $\mu\mu$f. Philips trimmer.
C_3, 500 $\mu\mu$f. mica.
C_5, C_7, 0.01 μf. paper.
C_6, C_8, 0.002 μf. mica.
C_9, 500 $\mu\mu$f.
C_{10}, 0.001 $\mu\mu$f.
R_1, 50k.
R_2, 1500 ohms.
R_3, 250k.
R_4, 600 ohms.
R_5, 2000 ohm pot.
V_1, V_2, EF91 or 6AK5

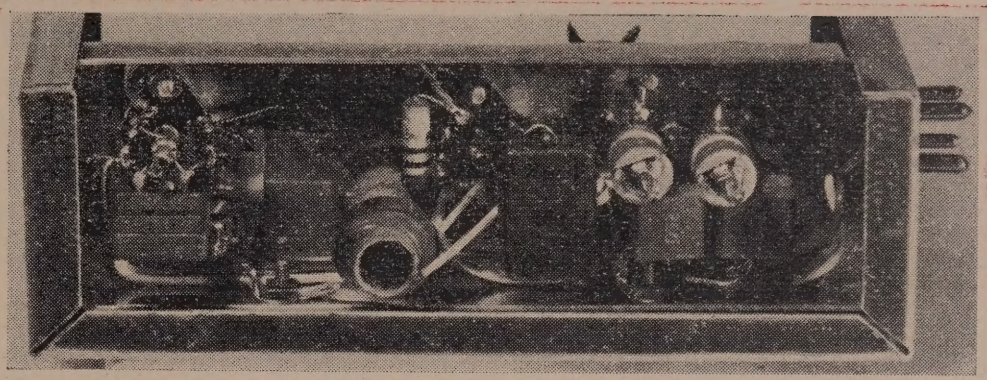
SPECIAL COMPONENTS

The circuit has the great advantage of requiring no special components that have to be made for it. For the cathode choke and the 100 kc/sec. oscillator coil, a 175 kc/sec. I.F. bobbin is used. It is cut in half between the coils, one being used for each purpose. Similarly, the coil for the 1,000 kc/sec. oscillator is an ordinary broadcast aerial or R.F. coil, with the primary removed, leaving only the one which is normally used as the tuned winding. Of course, various types of broadcast coil may be obtained, and their inductances will vary according to the gang condenser capacity for which they were designed. The one used in the prototype was for a 385 $\mu\mu$f. gang section, and was found to require a 250 $\mu\mu$f. fixed condenser in parallel with the Philips trimmer in order to bring the frequency within the range of the trimmer adjustment. This seems to be rather on the high side, until it is remembered that in the Clapp oscillator circuit, the stray capacities are very much smaller than in a conventional tuning circuit. There is no minimum capacity of the gang section, for instance, and the input capacity of the valve is merely connected in parallel with the large series condensers, and so has almost no effect on the frequency of the tuned circuit.

The 100 kc/sec. coil needed 500 $\mu\mu$f. fixed in parallel with its trimmer to bring it to the right frequency. It may be found that with the coils available, these capacity values may not turn out to be correct in all cases. This is only to be expected, because 30 $\mu\mu$f. is a very small proportion of even 250 $\mu\mu$f., so it might be found necessary to use more or less capacity for the condensers in parallel with the trimmers than we have specified. The total can be made up by two or more condensers in parallel, if this is necessary, but this will not matter, so long as all condensers used are high-quality mica ones. On no account should the tubular ceramic condensers that are now available be used, because these have quite high temperature coefficients, and will not give the stability that good postage-stamp micas will.

CALIBRATION

Naturally, when a device of this sort is constructed, it is helpful if it can be as accurate as possible. Fortunately, with the standard signals that are now on the air continuously from the U.S.A. standard frequency station WWV, this can readily be done at home, provided only that one has available a short-wave receiver that will pick up this station's transmissions on either 5 or 10 mc/sec. The method of using them is very simple indeed, but, first of all, it is necessary to set the 1,000 kc/sec. oscillator somewhere near the correct frequency. This can be done accurately enough for the purpose simply by using the calibration marks on a broadcast set whose calibration is known to be reasonably correct. The set is tuned to 1,000 kc/sec., and the oscillator trimmer (and fixed tuning condensers if necessary) are adjusted until the signal is received. Should the capacity required deviate too much from the value given in the parts list, it would be necessary to smell a rat, but such an eventuality is not very likely. About the only wrong adjustment that could be made would be to tune the oscillator to 500 kc/sec., in which case its second harmonic would come in at 100 kc/sec. on the dial of the set .However, if this were to happen, we would find that we had approximately four times the recommended capacity across the



Under-chassis view of the oscillator-multiplier unit. The oscillator socket is approximately in the middle of the chassis. The trimmers and their fixed condensers in parallel can be seen at the right, and the cathode choke at the left of the oscillator socket.

trimmer! With this preliminary adjustment accomplished, we now proceed as follows.

Turn the receiver to the shortwave band, and pick up WWV on either 5 or 10 mc/sec. Both transmissions are on 24 hours a day, and it does not in the least matter which one you use, except that it is much easier to use the one which is strongest at the moment. The output of the oscillator is then coupled to the aerial terminal of the set without disconnecting the aerial itself, so that the receiver can pick up both the signal from WWV and the harmonics of the oscillator. If by very great luck the preliminary adjustments were correct within a few hundred cycles, then as soon as WWV and the oscillator were tuned on together, a beat would be heard in the speaker. This is not very likely however, and with WWV tuned in, it will be necessary to tune the oscillator slowly and carefully on either side of the setting found in the first step. Unless the right frequency is not quite within range of the trimmer, adjusting it will bring in a squeal, which is a beat between WWV's carrier and the fifth or tenth harmonic of the oscillator. When this beat is found, all we have to do is to adjust the trimmer carefully for zero beat, and leave it set at that point. You will probably find that as the oscillator gets warmer, having been on for some time, it will slowly drift off zero beat, but this is no cause for concern. Remember that if WWV on 10 mc/sec. is being used, we are zero-beating the tenth harmonic of our oscillator. Thus, if after half an hour it has drifted off so that the beat note has risen to, say, 200 c/sec., this means that the oscillator, which is on 1 mc/sec., is still within **20 cycles per second** of its assigned frequency! This sort of stability can easily be obtained from a well-built Clapp oscillator after its initial warm-up period has passed, say, the first half-hour. Once the oscillator has been adjusted in this way, it is very accurate on frequency, and can be used as a check on the accuracy of the dial markings on a set. This may be the same set used to calibrate it with. The position of WWV on the dial will indicate absolutely the accuracy of the 5 and 10 mc/sec. marks, and the signals from the oscillator will show that of the intermediate points. If you find that some of these points are well out, whatever you do, don't alter the oscillator! The method of calibration used makes it hundreds of times more accurate than the frequency markings on any set, so that, if this occurs, it is the dial of the set that is out, and not the oscillator. You see, we have used the set merely as a means of receiving WWV, whose accuracy is about one part in ten million, and the exact position at which it comes in on the dial has no bearing at all on the calibration of the oscillator. Indeed, if the set had no calibration marks at all, it would not matter, provided we could find WWV's signal.

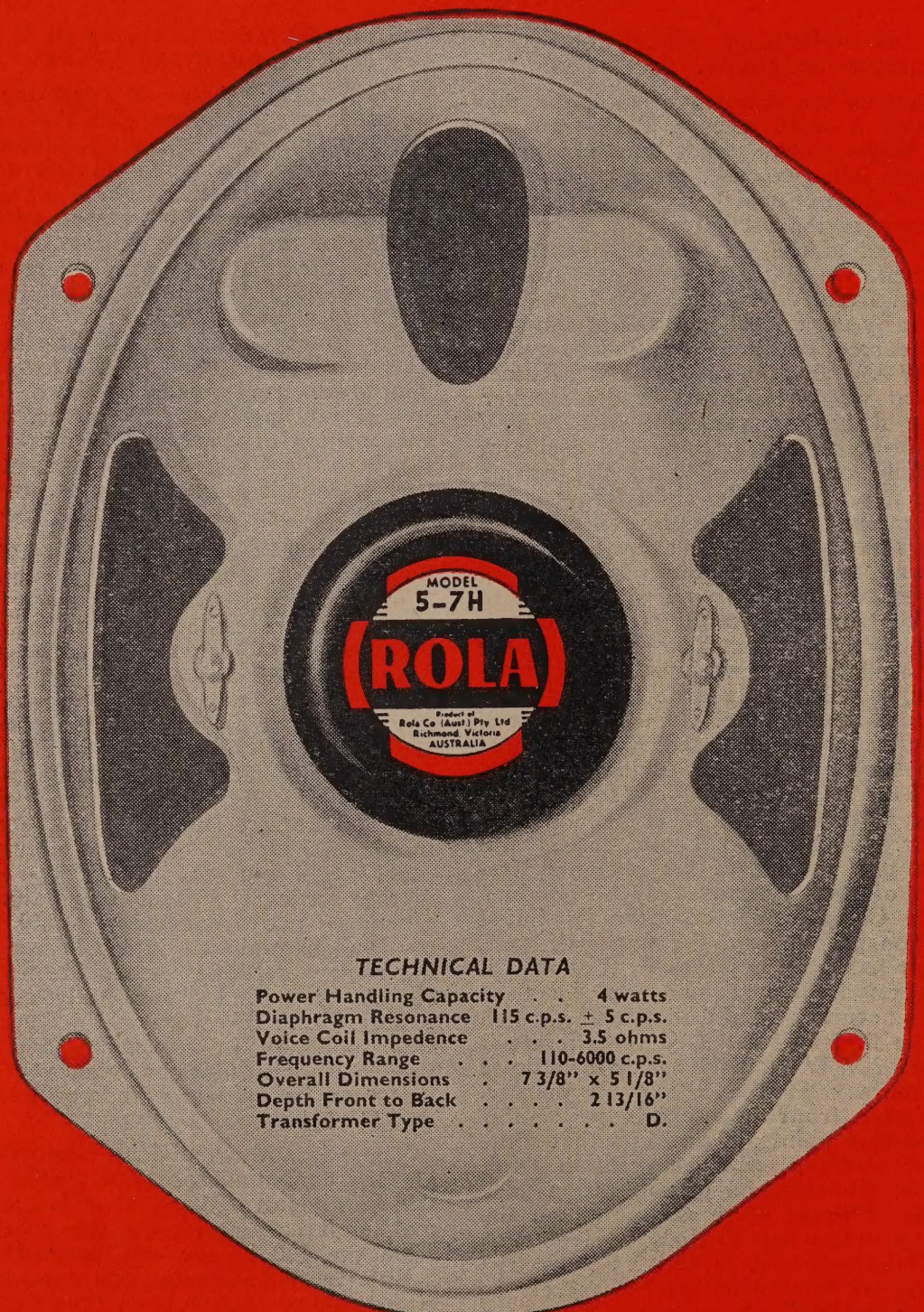
With the 1,000 kc/sec. oscillator calibrated, it can be used, in conjunction with the receiver, to calibrate the 100 kc/sec. series. As a preliminary adjustment, the set can be tuned accurately to 1,000 kc/sec. by using the oscillator switched to this frequency. Then it is switched to 100 kc/sec., without touching the setting of the receiver tuning. The 100 kc/sec. trimmer is then adjusted until a signal is heard on the same spot. This will be the tenth harmonic of the 100 kc/sec. oscillator if its setting is correct, and, in order to check this, the following method is used. The receiver is tuned to the low end of the lowest shortwave band available; in a three-band set the lowest multiple of 1,000 kc/sec. will be 3 mc/sec.; the position of this signal is marked. The set is then tuned to the 4 mc/sec. signal from the oscillator, and this position is marked. Now the oscillator is switched to 100 kc/sec., and the output turned full up.

If the 100 kc/sec. oscillator is correct, then we will find a signal exactly in the same position as the 3 mc/sec. one, another in exactly the same position of the 4 mc/sec. one, and, in between, there will be eight signals which can be counted. The series will actually be 3.0, 3.1, 3.2, 3.3, etc., up to 4.0 mc/sec. This business of counting the signals will tell without any doubts at all whether the oscillator is correctly set in the 100 kc/sec. position. If by any chance it is incorrectly set, not all of the signals mentioned will be observable. For instance, supposing it was actually on 111.1 kc/sec. In this case, there would be a harmonic on 3 mc/sec.—viz., the twenty-seventh, and another on 4 mc/sec., the thirty-sixth. In this case, merely setting the oscillator so that signals appeared on these two frequencies would not indicate that the fundamental was on 100 kc/sec. But if the counting trick were done, we would find that, between the signals on 3 and 4 mc., only **seevn** signals would appear. From this we would deduce that the oscillator was too high in frequency, and secondly that it produced only nine harmonics every 1,000 kc. At that rate, its fundamental frequency must be 1,000/9, or 111.11 mc/sec.

There is nothing difficult about doing all this. It is all just common sense and simple arithmetic, but it **will** be difficult if the receiver is not sensitive enough, making it hard to pick up the weak high harmonics from the 100 kc/sec. oscillator. However, by using a little more arithmetic, one can make use of broadcast stations' signals, and thus make it unnecessary to use such high harmonics. For instance, all we need to do is to find a broadcast station on a frequency

(Continued on page 48)

FOR BIG SET PERFORMANCE IN MIDGET SETS



TECHNICAL DATA

Power Handling Capacity	4 watts
Diaphragm Resonance	115 c.p.s. ± 5 c.p.s.
Voice Coil Impedence	3.5 ohms
Frequency Range	110-6000 c.p.s.
Overall Dimensions	7 3/8" x 5 1/8"
Depth Front to Back	2 13/16"
Transformer Type	D.

MORE ABOUT MAGNETIC AMPLIFIERS

In the November, 1953, issue of this journal, we featured an article which explained in a simple way the basic principles of magnetic amplifiers. In this article, some of the main types of magnetic amplifiers are further described, so that those readers who come up against them in their technical reading will be able to see at a glance what they are, and what they are supposed to do.

INTRODUCTION

Electronic circuitry is far from being a static thing. Indeed, it probably presents more new developments to an eager industry every month than are to be found in most branches of technology. Sometimes, the developments we refer to are far-reaching and exciting devices, such as the transistor, which bids fair to oust the vacuum tube, in the fullness of time, from many of its time-honoured applications. New applications of electronic techniques to industry see new branches of the art developed to a high degree almost over night, and they also bring to the fore older gadgets and artifices which suddenly assume new importance as a result of some much more recent invention.

One of these older devices which has recently come to the fore through the application of electronic control to industrial processes and in such up-to-the-minute devices as guided missiles, is the magnetic amplifier. It was invented many years ago—indeed,

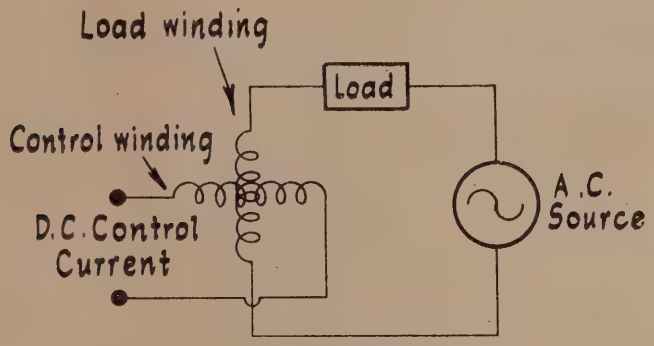


Fig. 1

before vacuum tubes were anything but a laboratory curiosity—but in the last few years it has undergone intensive development. As is usually the case when there is renewed interest in some technical device, this development has resulted in still more applications being found for it. What, then, are the special advantages of magnetic amplifiers that make them different from and preferable to valve amplifiers?

ADVANTAGES OF MAGNETIC AMPLIFIERS

These are many and various, but perhaps their most outstanding characteristic is that they do not use any valves, but only things which look just like transformers, but which are called **transductors,** and metal rectifiers. Because of this, they have nothing which compares with the heater or filament of a tube, and thus need no auxiliary power supplies. The only supply needed is a source of alternating current, which is controlled by the magnetic amplifier to produce a controlled flow of power from the A.C. source into the load device, which can be anything at all. It can, for example, be an electric motor whose speed must be controlled by an electric signal. This latter may be of infinitesimal power, and yet through the magnetic amplifier it may be made to control a motor of several horse-power. When it is remembered that one horse-power is equivalent to 746 watts of electrical power, it can readily be imagined that a control system using magnetic amplifiers could be considerably smaller and less costly than, say, a thyratron controller for a motor of the same power.

Another advantage of the magnetic amplifier is that it can do things that a valve amplifier cannot do directly. For instance, a valve is a device which, by means of an A.C. control voltage at its grid, controls the flow of power in an A.C. circuit (the plate circuit) which derives its power from a D..C source—viz., the H.T. supply. In the magnetic amplifier, on the other hand, the primary source of power is an alternating one, and control is effected by means of a relatively small direct current through the control winding. The load can be either an A.C. or a D.C.-operated device, and, in the latter case, the amplifier acts as a "D.C. transformer," since a small D.C. controls a much larger one.

It is possible to construct magnetic amplifiers so as to correspond with either voltage or power amplifiers of the valve-operated variety. That is to say, magnetic amplifiers can be built with very tiny cores, and thus with very small power outputs, but still with considerable amplification, while others can be made to handle almost any desired amount of power. In a given application, for example, it might be required to control a ten horse-power motor from a current of a few microamps, put out by a photo-cell. In a case like this, the control amplifier would probably contain two or three stages, each being a separate magnetic amplifier, and the whole lot being connected in cascade. A very small first-stage amplifier, for instance, might step up the photo-cell current of a few microamperes to several milliamps; these milliamps are then used as the control current for the second stage, which will give an output of several hundred milliamps, which in turn controls the output magnetic amplifier.

One of the most attractive features of the magnetic amplifier is that it has no parts of the kind which give trouble in service, and so is extremely reliable. Both transformers and metal rectifiers have almost unlimited life when properly constructed and used, so that reliability is better than that of any amplifier using valves, however reliable these may be.

Another advantage is that stage gains considerably greater than can be achieved with valves can be realized with magnetic amplifiers.

TYPES OF MAGNETIC AMPLIFIER

Magnetic amplifiers are of several kinds, which, circuitwise, look quite different. In fact, the differences are relatively slight, since no new principles are involved. All that differs as between one type and another is the manner of achieving the required

result. First of all, there is the simple magnetic amplifier, with only two windings. One is the load winding, and the other, the control winding. The load winding is in series with the A.C. power source and the load, and acts merely as a choke whose inductance can be varied by producing different degrees of saturation in the iron core. This partial or complete saturation is brought about by passing D.C. through the control winding. The theoretical diagram normally used to show this type of magnetic amplifier is shown in

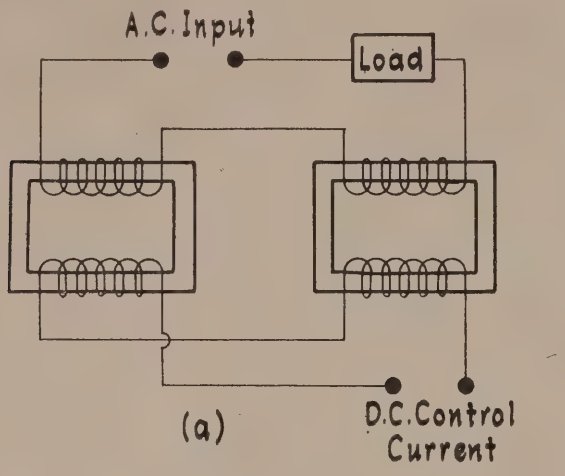


Fig. 1. The two windings are usually drawn at right-angles, to indicate that there is no transformer action between them. That is to say, the presence of A.C. in the load winding does not result in an alternating voltage being used in the control winding. In most cases this would be undesirable, since the control circuit is a D.C. one, such as the plate circuit of a valve, or the load circuit of a previous magnetic amplifier, and in either case the presence of A.C., fed in from the amplifier core by transformer action with the load winding, would be detrimental. In practice, this independence is obtained as was explained in the previous article, and as illustrated in Fig. 2. At (a) is shown one of the two stock methods. It consists of having two entirely separate iron cores, and splitting both load and control windings into two equal parts, one of which is on each core. The load windings are connected either in series or in parallel, while the halves of the control winding are connected in series in such a way that the alternating voltages induced in each half cancel out. As long as the cores are identical, as well as the halves of the two windings, this cancellation will be exact.

In Fig. 2 (b) is shown the other method of cancelling the A.C. from the control winding. This time only one core is used, and only the load winding is split into two halves. These are placed on the outside legs of the core, while the control winding occupies the centre leg. The connections of the two halves of the load coil are so made that the alternating magnetic fluxes in the centre leg are in opposite directions, and so cancel out. There can thus be no alternating voltage induced in the control winding. The direct flux produced by the latter, however, divides, and half passes through each ring, so that both halves of the load winding are equally affected by the control current.

This type of amplifier has a current amplification which depends directly on the ratio of load-winding turns to control-winding turns. In other words, doubling the control turns makes it possible to control a given amount of current in the load winding with half the control current, so that by having a very large number of control turns, the current amplification can be very great. Unfortunately, there is a good reason why this process cannot be continued indefinitely in order to increase the sensitivity. It concerns the time-lag between the alteration of the control current and the response of the load circuit. Everyone

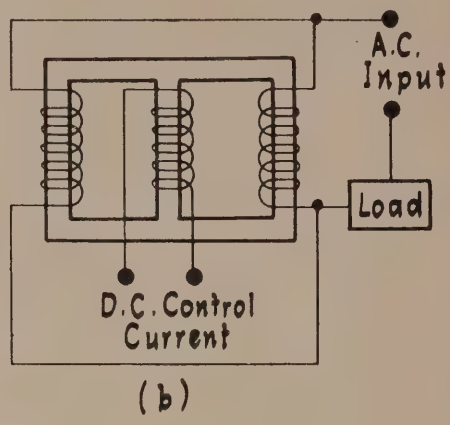


Fig. 2

is aware that current in an inductance cannot change instantaneously. The greater the inductance in the circuit, the longer the current takes to change from one value to another. Increasing the number of control turns increases the inductance of the control winding at a much faster rate than that at which it increases the amplification, so that if sensitivity is obtained by using a large number of control turns, the frequency response of the amplifier is very seriously restricted. It is one of the disadvantages of the magnetic amplifier that the frequency response is not nearly as wide as can be obtained with valve amplifiers. However, some of the other more complex arrangements which we are about to describe have the advantage that they produce very high gain with quite wide enough frequency response for most control purposes. In control circuits, the response required is not usually required to extend even to medium audio frequencies, so that wide-band response is not needed, which is just as well!

There are two ways of connecting the load windings in the circuits shown in Fig. 2, since they can be connected either in series or parallel. There are advantages and disadvantages in both connections, however, and a rather more advanced treatment than this one would be needed to discuss the point.

The iron-cored device itself does not in general make up the whole of a magnetic amplifier, as we shall shortly see; in the simple cases we have so far been discussing, it does, but in order to distinguish it as a component part of more complex magnetic amplifiers, the core or cores, together with their windings, are called **transductors**—not to be confused with transistors, however!

FEEDBACK APPLIED TO MAGNETIC AMPLIFIERS

If the thing which is to be controlled needs D.C. to operate it, and not A.C., it can still be worked by a

magnetic amplifier by inserting a bridge rectifier, just like those used to convert D.C. milliammeters to read alternating current. In this case, A.C. still flows in the load winding of the transductor, but D.C. flows in the load device. By this means, the amplification from a small D.C. control current to a large D.C. load current is obtained. Now, it is possible to place such a rectifier in the circuit of the load windings whether or not the device to be operated is an A.C. or a D.C. one. It is also possible to put on the core a third winding, over the top of the control winding. In this way, the third winding, too, receives no A.C. from the load windings. It is connected at the output of the rectifier, so that rectified A.C. from the load circuit is passed through the third winding. Moreover, it is connected in such a polarity that the D.C. passing in it aids the control winding in producing its D.C. magnetization of the core. The whole arrangement is clearly an application of the positive feedback, and is shown in schematic form in Fig. 3. Note that the feedback winding (as it is called) is drawn parallel to the control winding to indicate the way in which it is placed on the core. This means in practice that with the two-core transductor the feedback winding is split into two parts, just like the control winding, and that these parts are wound in the same directions, and connected in the same way as the control windings—i.e., so that no A.C. is induced in the feedback circuit.

This kind of amplifier can be made to have very much more gain than the simple type, and with fewer turns on the windings. It produces what may be termed an ampere-turn gain, in addition to any gain that may be obtained by using many turns on the control winding. To explain this latter term, and at

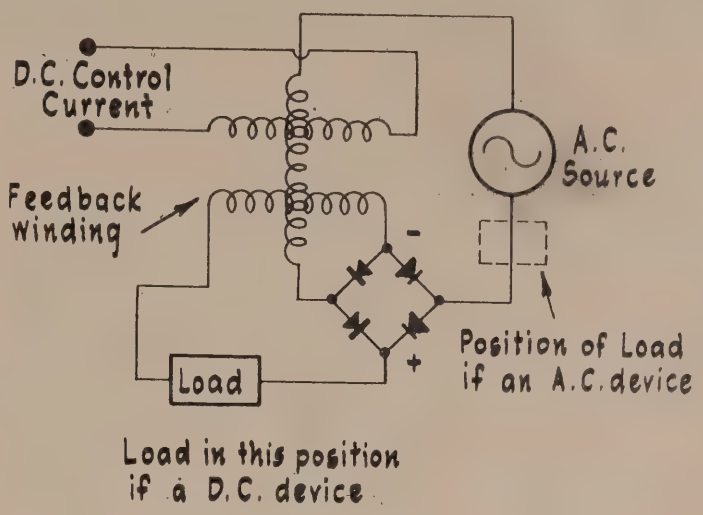


Fig. 3.

the same time to illustrate the sort of performance that can be obtained from a magnetic amplifier, the curves of Fig. 4 have been drawn. These curves represent the input-versus-output characteristic of the

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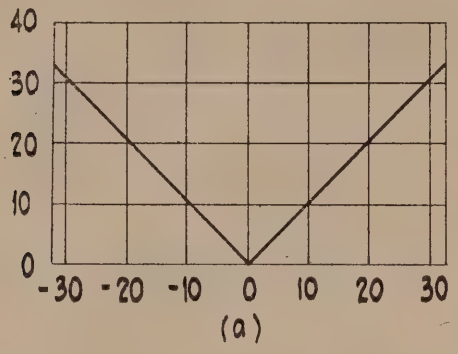
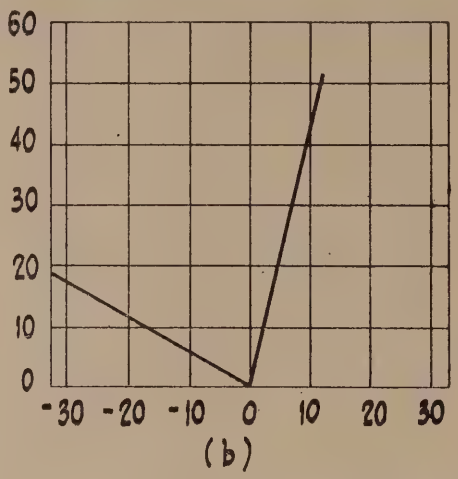
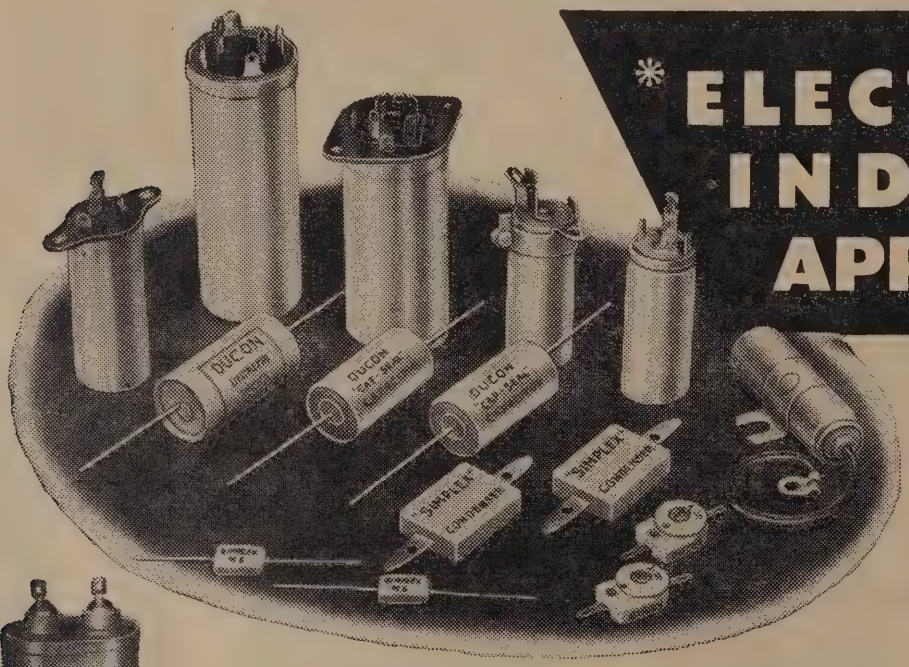
amplifier. Now, since the input is a certain magnetization of the core, which can be measured in ampere-turns, without specifying the number of turns on the control winding, and because, also, the output can be represented by the number of ampere-turns in the load circuit, the curves are plots of input ampere-turns versus output ampere- turns. These curves





are drawn from a series transductor—that is, one in which the load windings are connected in series. At (a) is shown the curve for a simple transductor, with no feedback winding, while at (b) is shown the result of using a feedback winding. In the former case, it can be seen that there is no ampere-turn gain at all, because the curve is a pair of straight lines with 45° slopes. This means that an input of one ampere-turn gives an output of one ampere-turn. There are two lines, converging at zero output for zero control current, and this is simply because the control current can be made to flow in either direction through the winding, without altering the behaviour at the output in any way. The latter point is illustrated by the fact that the curves are exactly symmetrical. At (b) in Fig. 4, it can be seen that when the control current flows in one direction, the curve is very much steeper, indicating that a control input of 10 ampere-turns produces an output of 45 ampere-turns. We thus have an ampere-turn gain of 4.5 times, so that the feedback has increased the sensitivity of this factor. The gain can be very much greater than this, and it is obtained simply by increasing the number of turns on the feedback winding.

(Continued on page 33.)



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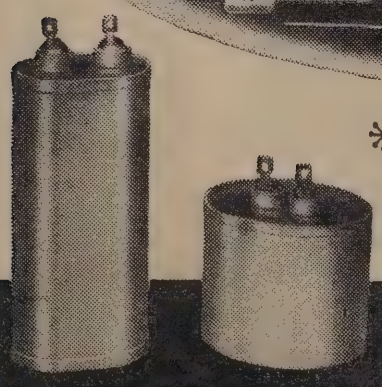

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Some Aspects of the Design of Master Oscillator Power Amplifier Type Transmitters

By PHILIP HOWELL

INTRODUCTION

There are a number of aspects in the design of MOPA transmitters which are not mentioned specifically in the majority of texts treating them, although, of course, they are implied by the theory. In view of the difficulties which may be encountered through neglect of their consideration, it seems worth while to bring some of them to notice, since the information may be of some value to communications technicians and amateurs.

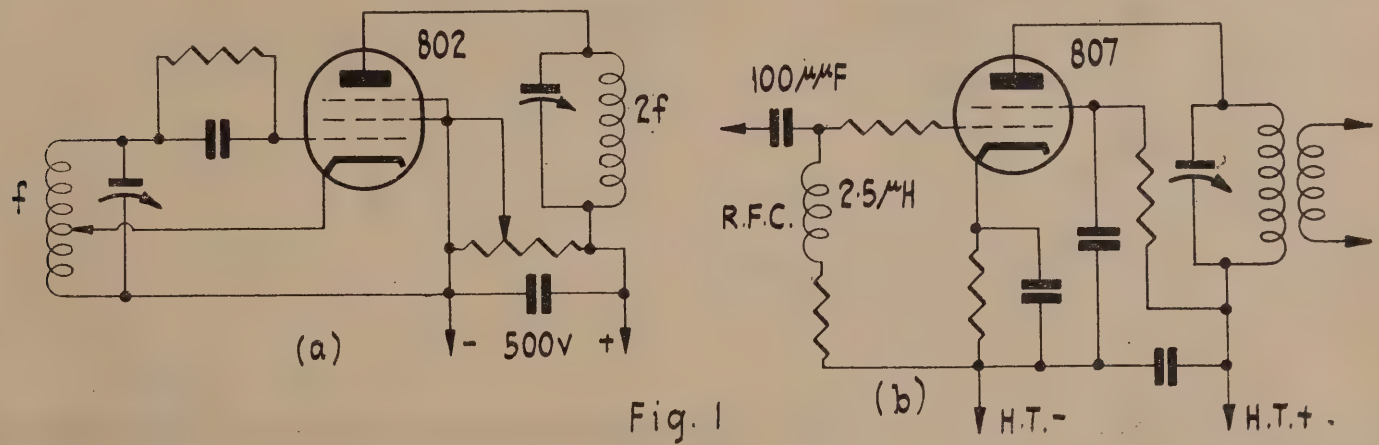

Fig. 1

THE APPEARANCE OF THINGS

From a theoretical point of view, stable operation of an MOPA transmitter may be achieved by employing either neutralized triodes or screened tetrodes (or pentodes) in the amplifier stages. Circuits are published whole or in part, and in such a manner that it is implied that there are a number of configurations of oscillator and amplifier arrangements which will work equally well in conjunction with one another. In fact, it is often stated that their association is a matter of choice which may be made upon the basis of equipment available.

As an example, consider the following:—

In Fig. 1 (a) is an electron-coupled version of the "inverted" Hartley oscillator, with provision for frequency doubling in the anode circuit. It is presented, quite justifiably, as an ideal form of stable, variable frequency master drive which may be kept well within the prescribed tolerances laid down for stability on any frequency within the M.F. or H.F. range if properly constructed. And it is undoubtedly a fine drive unit in its own right; perhaps the best readily attainable. Figure 1 (b) is a conventional H.F. power amplifier stage, capable of being modulated, etc. The intending constructor probably knows both circuits well, their merits having made them known. Together they appeal as an ideal combination for a mobile communications transmitter. Construction is commenced.

What is not obvious, however, is that in association the buffer section of the Dow oscillator has turned the P.A. stage into a T.A.T.G. oscillator. Consider Fig. 2:

Although it is true that the P.A. valve is a specially designed H.F. beam type, the grid anode capacity is still between one-tenth and two-tenths of one picofarad, and has a reactance which is not negligible in relation to the high impedance anode circuit of the oscillator which is chosen to have a high value of dynamic resistance.

If the construction has been carried out carefully, the beam valve being mounted "torpedo" fashion, with a short shield about the base, the valve may not show any tendency towards self-oscillation, especially if the amplifier is tested with the load connected. If, however, a sensitive milliameter (0-1 ma. or less) is connected in series with the earthed end of the grid-leak, or if a sensitive thermo-milliameter (300 ma. or less) is connected across the output link and the full H.T. voltage applied in the absence of any drive from the oscillator, it will indeed be surprising if no tendency towards T.A.T.G. oscillation appears. (Need it be said that this is NOT the sort of test which is made in a leisurely way if any respect is had for the valve's life!) Provided that there is no sign of the stage oscillating on load, it may be thought that the regeneration might be regretted. For CW telegraphy

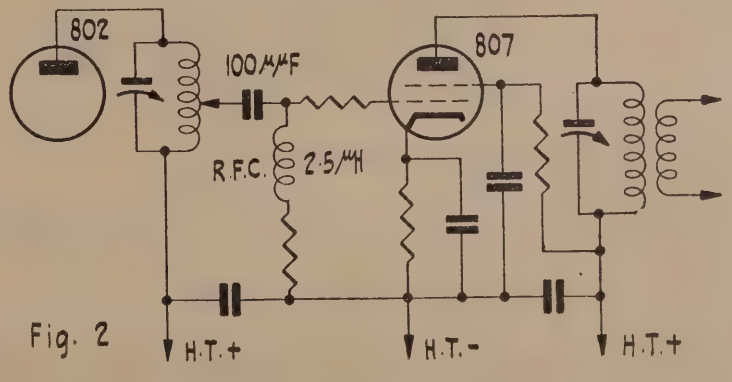

Fig. 2

working, this is a justifiable attitude. On telephony, however, with anode modulation, the P.A. stage will be prone to burst into oscillation during the positive

excursions of the modulation with a random phase relation causing unwanted frequency modulation and scintillation as well as amplitude distortion. This is recognizable sometimes by the rather blurred and furry characteristic sound of the radiated signal.

REMEDIES

Strictly speaking, there is no complete solution to this problem other than the adoption of some form of neutralizing, with its attendant difficulties, although a satisfactory compromise may be achieved in the following manner:—

Examination of the grid current while the P.A. stage is under drive from the oscillator will probably

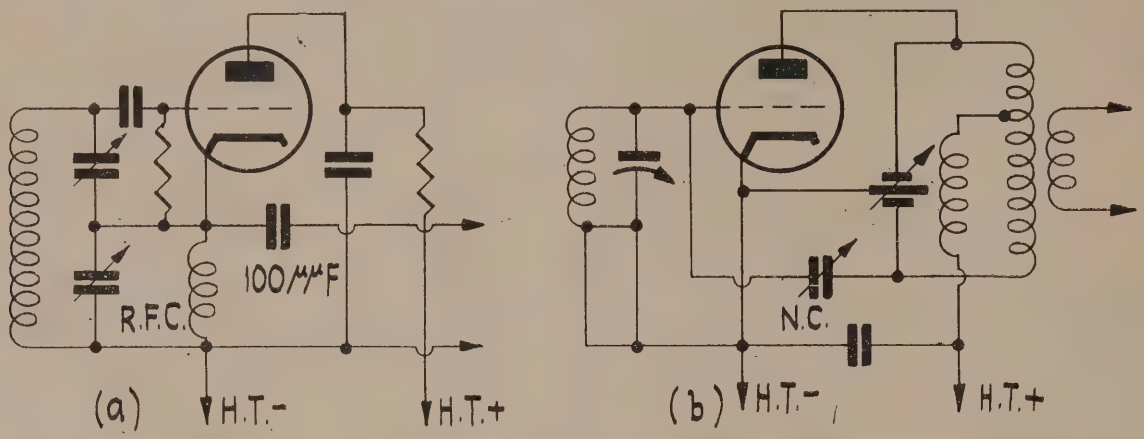

Fig. 3

show that it is several times too high, especially if the published values of coupling have been adhered to, and the proper anode voltage is being supplied to the oscillator. The extra drive will have to be reduced, of course, and the proper way under the present circumstances is to increase the reactance of the coupling. The capacity is shown as 100 pico-farads. This should be replaced with a 3 to 30 pfd. variable (having adequate insulation) and the amount of capacity in circuit reduced until the grid current reads about 2.5 ma. with the P.A. fully loaded. The reduction of the coupling capacity increases the isolation of the resonant circuit in the anode of the oscillator from the grid of the P.A. stage, and with care in the rest of the design this isolation may be sufficient to reduce the regeneration to acceptable proportions. An oscillographic examination of the waveform under consideration is perhaps the only certain way of ascertaining this; in practice, however, if the aforementioned test is repeated and no tendency towards instability shows for any setting of the final tuning condenser, the stage may be considered passable for modulation.

DEGRADED CONDITIONS

The odds are, though, that this will not have been sufficient, especially in the following circumstances. Probably it will have been recognized by the designer that the P.A. stage does not require anything like the amount of drive available from the oscillator as portrayed, so, for reasons of power supply economy, he will have substituted a valve of much lower anode rating and heater consumption for the one shown. The type 802 might have been replaced by a 6AG7, 6AC7, or some other fully shielded H.F. valve which draws a considerably lower anode current at 250 to 300 volts against the 500 volts specified for the original, with an apparently worth-while saving in the watts lost in the oscillator stage. In consequence of the lower output voltage of the oscillator, the reactance of the coupler (which is acting as the upper limb of capacity voltage divider) must be reduced in order to achieve sufficient grid drive, and this, as has been shown, increases the tendency to T.A.T.G. oscillations. In those cases where the stability has been further degraded by the substitution of a pentode or beam valve designed for speech frequencies, such as 6L6G or KT66, to replace the 807 P.A., the position is hopeless without neutralization.

SOME CONCLUSIONS

It may be justifiably concluded then that the theoretical value of power supply economy may not be approached in a design of the sort under discussion without resorting to neutralization of the H.F. P.A. stage employing a pentode or beam valve, since sufficient coupling to obtain adequate drive for anode modulation is rarely obtainable without interference from the development of T.A.T.G. oscillations. It may be added also that the simple form of neutralization frequently favoured in these circumstances, consisting of a few extra turns wound on to the bottom of the tank coil, is satisfactory over only a limited range of frequency, and requires re-setting with appreciable change of frequency.

SOME FURTHER UNPLEASANT POSSIBILITIES

Naturally, in a similar fashion, T.A.T.G. oscillations may develop in the final stage of a three-stage transmitter due to the anode load of the buffer acting as the tuned grid circuit of the P.A. stage, although the buffer itself is running as doubler stage. Where the oscillator employed has a crystal as resonator, the effect is not infrequently masked by synchronization of the spurious oscillation occurring. That is to say, instead of the T.A.T.G. oscillations occurring with random phase relation to the deliberately generated oscillation, the latter, being less prone to being pulled, locks the former to its own value. They thus remain undetected unless the oscillator is stopped and the transmitter output is discovered almost uninfluenced in amplitude. This effect is perhaps the otherwise unjustifiable reason for the belief prevalent in the amateur world that the presence of a crystal improves the

overall stability of a transmitter. It follows from this that in every case provision should be made for applying the full operating potentials in the absence of drive to each stage in order to check its tendency to self-oscillation, more particularly in view of the fact that the state of affairs described is largely independent of shielding and lay-out, and may occur with the best design and construction.

ET TU BRUTE!

Lest it should be concluded that this nuisance may be avoided by the employment of tuned neutralized triode stages, consider again the circuits depicted in Figs. 3 (a) and (b):

Today, there is an increasing tendency to revert to this type of circuitry, since it has become generally realized that the performance of the simpler feedback oscillators is as much a function of proper lay-out and materials for construction as it is of any particular circuit type. (This is borne out by the evident stability of the perfectly conventional Reinartz and T.N.T. circuits used almost without exception in dual-wave domestic superhets.) The significant difference, however, lies in the fact that the oscillator is adjusted for operation between Class AB_2 and B_2 in order to increase the stability and reduce the harmonic output, and no attempt is made to achieve the optimal compromise between efficiency and output, which was the aim in the middle 1920s. This is practicable because the buffer stage is run in Class A, and has relatively small drive requirements.

Again consider the circuits in association:

When the tuned circuit in the grid of the buffer is associated with the oscillator and the coupling is tight, it is not unfair to say that the oscillator ceases to know whether it is intended to be running as a Colpitts or a T.A.T.G. Yet there is nothing to suggest in theory that the two circuits may not be associated.

MORE REMEDIES

In practice, this may be obviated to some extent by reducing the value of the coupling as in the previous case; however, a more reasonable solution is found in dispensing with the tuned grid input circuit of the buffer stage. Since the latter is running Class A without grid current flowing, the power requirement is so small that a tuned circuit is not really required to hold up the voltage at the grid, and the arrange-

(Continued on page 31.)

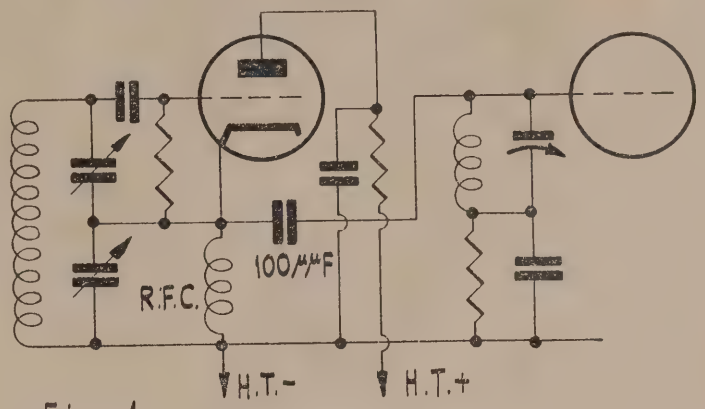

Fig. 4

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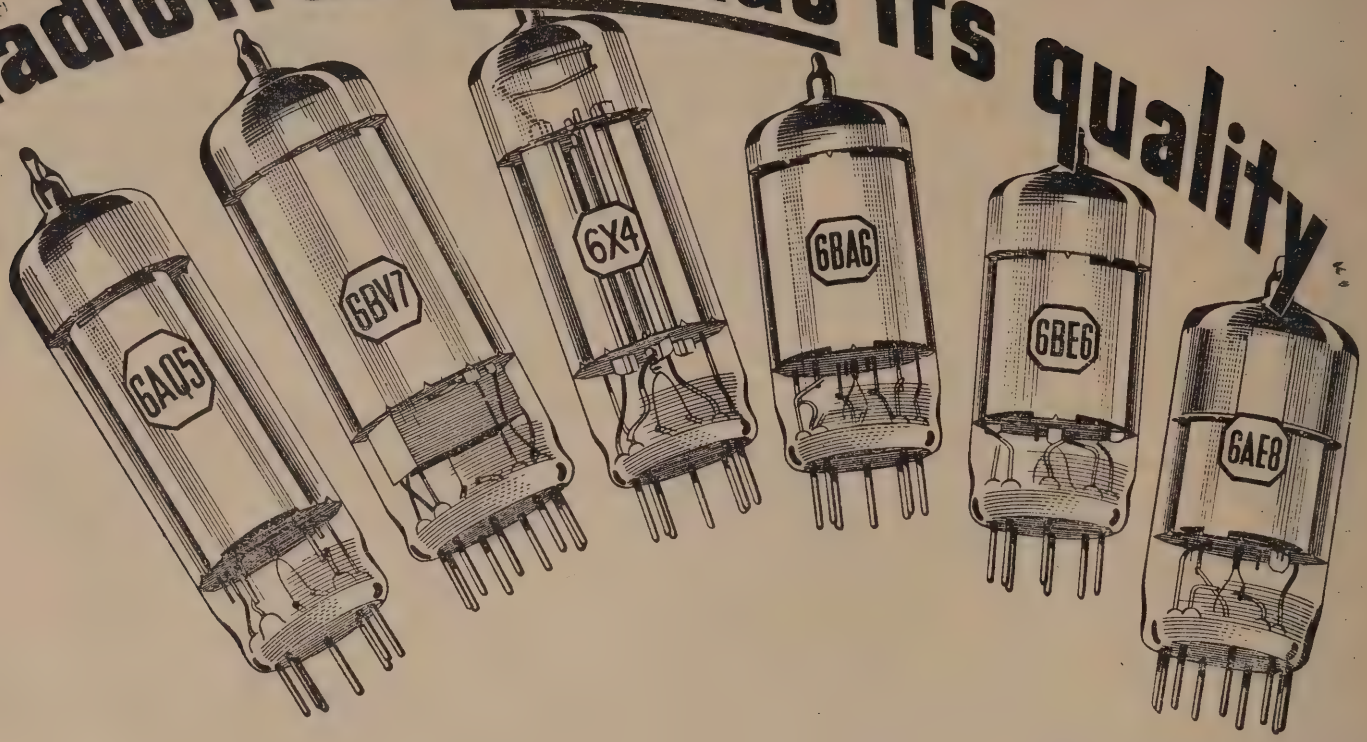
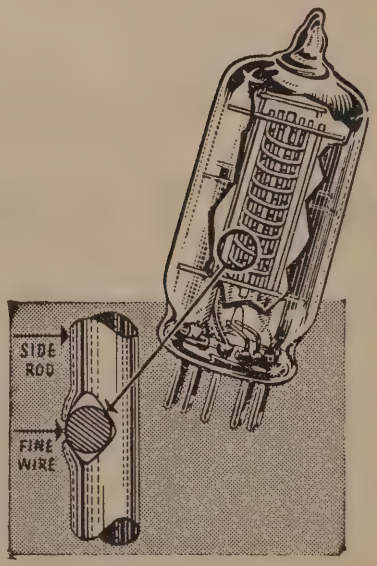


The consistent and uniform characteristics of Radiotron valves is largely due to the effectiveness of the quality control measures enforced at all stages of their manufacture.

Perhaps, nowhere, can a better example of this be found than in the fabrication of the grids which are used to control electron flow within the valves.

These grids are precision wound with extremely fine wire in a variety of sizes, and have the ability to retain their shape under conditions of shock and vibration.



Before use, the grid wires are critically inspected for size, strength, consistency of diameter, straightness, uniformity, and freedom from contamination.

The diameters of wires used for grids vary between 0.002 in. *and* 0.005 in., *while the diameters of the supporting wires or side rods range from* 0.025 in. *to* 0.030 in.

Material used to manufacture the grid wires and side rods must have certain desired mechanical, thermal, and electronic properties. For the grid wires, a special manganese nickel alloy is used which retains its shape and strength at high temperatures. The side rods are made from nickel and copper alloys.

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THE APPLICATIONS OF TELEVISION TO INDUSTRY

An address given to the Electrical Section of the New Zealand Institution of Engineers at Wellington on 16th September, 1953.

By W. L. HARRISON, B.E., B.Sc., A.M.I.E.E.

INTRODUCTION

In the minds of most of us here in New Zealand the word television conjures up visions of entertainment brought to us on a screen in our homes, which will save us waiting in a queue for the theatre or cinema, or going out on a cold and wet day to see the races or the rugby. What is not so well known is the fact that television is opening up a new era in the realm of industry, research, and education, which may well compete in coming years with television as an entertainment medium.

Television essentially is a very ingenious method of providing a remote indication of some happening—not by meters or recorders—but by conveying and reproducing the actual scene just as the human eye would see it, or even better; and this instantaneously, too, without any time-lag such as exists in photographic processes!

While the technique of television today is bound up with electronics and photo-electrics, it can be said that only two years after the discovery of the photo-resistive property of selenium in 1873, Cary made the first steps towards television with his proposal to imitate the human eye by mosaics of large numbers of selenium cells. Hertz, who discovered the photo-electric effect a decade later, Nipkow and his scanning disc in 1884, and Rignoux and Fournier, who transmitted simple patterns in 1906, followed by Baird and Zworykin in the early 1930s, were the forerunners of the great army of scientific workers who have contributed to television as it is known today. The radio, electrical, and photographic sciences have poured into this art the wealth and experience of a multitude of pioneer physicists and research laboratories all over the world.

PART I

Now a few words about how television works.

As an introduction to the methods employed in television transmission, it is convenient to discuss the familiar methods of visual representation employed in photography and photo-engraving. These methods differ in many essentials from those employed in television, but they serve to introduce the important concepts of picture element and image repetition, which are basic to the television transmission process.

When photographic or printed images are examined closely, they are found to consist of elemental areas of light and shade, corresponding to the illuminated areas previously mentioned. In photographic negatives and prints, this fine structure consists of grains representing a detail or a portion of a detail of the image. In photo-engraving the printed scene is composed of many fine black dots, displayed against a white background. The dots are all equally black, but they differ in size and in separation one from the other, and are thus able to represent a variety of tonal values and details. The printed dots are examples of picture elements. A picture element is an elemental area of an image, having a uniform tonal value within itself and corresponding in size to the smallest detail which can be represented in the image.

The number of picture elements in an image represents the maximum amount of visual information which may be conveyed by the image. In photography, the size of the silver grains is fixed by the emulsion, the exposure, and the processing, so the number of picture elements increases in direct proportion to the area of the negative or print. An 8 in. by 10 in. glossy contact print, reproduced by contact printing from a fine-grain negative of similar size, contains about 150,000,000 picture elements. Professional 35 mm. movie frames display about 1,000,000 picture elements, 16 mm. home movies about 200,000, and 8 mm. home movies about 50,000 elements.

The concept of image repetition arises when motion must be depicted in the reproduction of a scene. In direct vision, the eye registers continuously; but in photography, it is not possible to change the intensity of the silver grains, which remain fixed and static after processing. So it becomes necessary to adopt some method which will represent motion in terms of static images. This method, the basic principle of motion pictures, is the rapid, successive presentation of a large number of static images, each of which differs very slightly from those preceding and following it.

A motion-picture film consists of a great many such static pictures, each of which remains stationary in the projector for a brief time, during which it is revealed to the eye. Between these successive projections, the light is cut off by a shutter in the projector, and the next frame is moved into position. If the rate of image repetition is high enough, persistence of vision causes the sensation of light in the mind of the observer to carry over from one frame to the next, and the observer is not aware that the light is, in fact, completely cut off between frames. Moreover, if the rate of repetition is high enough, the continuous displacement due to motion in the original scene is reproduced by small discrete displacements which are not separately perceived by the eye.

The process of image repetition thus brings with it two problems not met in direct vision: (1) The light from the image is, in fact, discontinuous, and its discontinuous nature may become evident as a flicker, if the rate of repetition is too low; (2) the motion represented by repeated images is not continuous, and this discontinuity may become evident if the distance traversed by the object between frames occupies too large a portion of the field of view. These effects must be taken into account in the design and operation of television and motion-picture systems. In particular, the rate of image repetition must be chosen with reference to the maximum brightness to be encountered in the reproduced image, since the perception of flicker increases markedly as the image becomes brighter.

In motion pictures, the basic frame repetition rate is 24 frames per second, a value chosen as a com-

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promise between the consumption of film on the one hand and the necessity of minimizing flicker and jerky motion on the other. As this frame rate is not high enough to secure freedom from flicker, even at the low brightness levels permissible in darkened theatre., the rate is increased to 48 per second by interrupting the light briefly during the projection of each frame. A similar technique, known as interlacing, is employed in television to double the effective frame rate.

ELECTRICAL TRANSMISSION OF VISUAL INFORMATION

The transmision of visual information by electricity is limited by the fact that a single electrical-transmission circuit can carry but one item of information at a time. In general, these items of information are conveyed by current impulses that are caused to flow through the circuit by corresponding voltage impulses generated by the transmitting equipment. If several such voltage impulses are applied simultaneously to the circuit, the corresponding current impulses lose their separate identities in the circuit and cannot be separated at the receiving end of the line.

With this limitation of transmission circuits in mind, we recall that a scene consists of a great many picture elements, which are perceived simultaneously by the eye. Signals representing all the picture elements cannot be conveyed simultaneously by a single electrical communication channel. Hence it would seem necessary to provide a separate communication circuit for each picture element and to cause each circuit to respond only to the changes of the associated picture element.

This method of transmitting visual information has been experimented with, but it has proved practical only when the number of picture elements in the picture is small and when the distance of transmission is short enough to make feasible the great number of separate circuits required. Animated electric signs, in which lamp bulbs are used for picture elements, each wired to a separate circuit, are to date the only practical application of this method of transmission. For pictures containing 100,000 picture elements or more (typical of modern television practice), it is obviously impractical to provide the necessary number of individual circuits for this method of transmission.

The alternative is to employ one communication channel and to send the picture-element impulses one after the other ("sequentially") at a rapid rate. This sequential method of transmission is used universally in television. The effectiveness of this method rests on that fortunate property of the eye, persistence of vision. If the eye were instantaneous in its action, the sequential method would fail, since the eye at the receiver would then see each picture element individually and separately. As it is, the impression made by any one element persists in the mind for a small fraction of a second. During the interval of persistence of this one element, all the others are presented successively to the eye in their proper positions. In effect, the eye operates as though it were seeing all the elements at once, and the simultaneous aspect of direct vision is re-created artificially.

The persistence of vision is a complicated phenomenon. The persistence of the sensation of light is very definite and marked for a short period after the light stimulus is removed, after which the sensation gradually dies away. Experience with motion pictures has revealed that the projected image appears continuously illuminated if the individual light impulses from the projector are presented to the eye at a rate of 40 to 50 a second. If they are presented at a slower rate, the sensation decays to a low level between the light impulses, and flicker is apparent, at the usual brightness levels required in theatres or homes.

To avoid flicker in television, it has been found desirable to transmit all the elements of the picture in approximately one-thirtieth of a second. Since a very large number of picture elements, approximately 150,000, must be transmitted in this short time, it follows that the rate of transmitting them reaches several million per second. Actually, a rate as high as 8,500,000 picture elements per second occurs in the operation of the commercial television system, according to the standards currently in use in the United States. The problem of dissecting images and reassembling them at this rapid rate has been solved by the use of cathode-ray camera tubes and picture tubes, which employ free electrons capable of moving with the necessary agility.

SCANNING—THE SEQUENCE OF TRANSMITTING PICTURE ELEMENTS

It is evidently necessary, in the sequential method of transmission, to select the picture elements from the scene in some orderly sequence and to reassemble them in the image in the same sequence. Any convenient pattern of selection would suffice, provided the same pattern were used at transmitter and receiver. Many such patterns have been proposed and studied. The method universally used in practice is known as "uniform linear scanning."

The word "scanning" arises from its similarity to the action of a reader scanning a page of printed type. The eye begins at the upper left-hand corner of the page and travels along the first line of type until it reaches the right-hand edge of the page. There the eye quickly reverses its motion and returns rapidly to the beginning of the next line, where it resumes its slower left-to-right motion, travelling to the end of the line, then back, and so on.

A very similar motion is employed in television scanning. The picture elements, actually distributed uniformly over the picture areas, are considered to lie in parallel horizontal rows, much as the letters of print are arranged on a page. When the transmission of the pictures begins, all the picture elements present in the topmost row are selected, one after the other from left to right, and converted into corresponding electric signals which are sent successively over the communications channel. When the first row has been scanned, the picture elements in the third row (which lies parallel to and one row removed from the first row) are selected in the same fashion, followed by the elements in the fifth row, and so on, until the bottom row of the picture is reached. Then the area is covered again, as the elements are selected from the second, fourth, sixth rows, and so on. In this manner, the whole area of the picture is systematically explored for the information it contains in two sets of parallel lines. At the receiver, the electric impulses are translated back again to light impulses, and these impulses are assembled before the eye in the same scanning sequence.

The scanning process must proceed at a very rapid pace, of course. If the eye is to see the whole picture at once, it is necessary that the last picture element

in the last row in the array be presented to the eye while the impression from the first element in the first row still persists in the eye—that is, within approximately one-thirtieth of a second. Within this short time it is necessary that all the elements of the picture be so presented that the eye sees the picture "all at once."

The entire process is then immediately repeated, and a new picture, differing somewhat from the first, is sent in the same fashion. At the end of one second 30 complete pictures have been sent. Any motion which occurs in the scene during that time is thereby divided into 30 smaller motions which, viewed by the eye, appear to blend smoothly and continuously one into the next.

It will be noted from the above description that the scene is scanned in two separate groups of lines: the odd-numbered lines, followed by the intervening even-numbered lines. This method is somewhat similar to that used in motion pictures—that is, the presentation of each picture is divided into two intervals. In television, however, it is not necessary to interrupt the projection of each picture with a shutter as is done in movie projectors, since that would merely obscure some of the lines in the image. Instead, the interlaced sequence just described is used. At the conclusion of the two interlaced scans, each point of the image has been scanned only once, but the eye has received two light impressions from the picture area. The picture-repetition rate is thus effectively doubled, and the picture information remains unchanged. Interlaced scanning is now universally employed in the television systems standardized throughout the world. world.

TRANSMISSION AND REPRODUCTION

In actual practice, the scene to be televized is focused by conventional camera lenses on to a photosensitive plate contained in the electronic camera tube. The picture on this plate is scanned by a beam of electrons and the beam current varies as it moves depending on the light and shade of the picture. The variations are amplified and form a pulsating current of a very high frequency. This current can be carried to the distant viewing set either directly by cable (a special coaxial cable having low losses at these high frequencies) or by a radio transmitter "carrier wave." In the receiving set there is a cathode ray tube which has an electron beam similar to the camera tube and moving in the same way and at the same speed. The pulsations of the current originated by the camera tube are now used to vary the intensity of this fluorescent face of the cathode-ray tube as the beam moves backwards and forwards in the scanning process.

(To be concluded in next issue.)

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Book Reviews

"Television Engineering: Principles and Practice," Vol. I, by members of the B.B.C. Engineering Training Department. (Publishers, Iliffe & Sons Ltd.; price, in United Kingdom, 30s.)

This is the first volume of a complete text on television engineering ,written by members of the B.B.C. Engineering Training Department, primarily for the instruction of the Corporation's own operating and maintenance staff. The work is intended to provide a comprehensive survey of modern television principles and practice, on both the transmitting and receiving sides.

This first volume is divided into three main parts—namely, Fundamentals, Television Camera Tubes, and Television and Electron Optics.

Part 1, consisting of two chapters, deals with the fundamental principles, and with the composite signal waveform. This section of the book is brief and to the point, providing, in the space of 38 pages, all the essential information concerning image dissection and synthesis, and such all-important matters as the D.C. component of the television signal.

Part 2 gives a very complete description of all the types of camera tube now in use, not to mention other types which are not. In this, the authors do not confine themselves to tubes which are in service with the B.B.C. To a large extent, the treatment is general, and it includes the best description of the differences between low and high-velocity tubes this reviewer has yet seen. In particular, the question of the potential at which the scanned target resides is well and clearly explained.

The treatment of the third portion of the book is biased rather more towards the purely optical side of the question than one would perhaps expect to find, but, in the writer's opinion, this has two important advantages. For those concerned with transmission, an understanding of the optical side of camera work is no less important than the electronic, and at the same time, this material forms an excellent introduction to what is really a very similar subject, electron optics. This latter is of the first importance to both the transmitting and receiving ends of the television system, and is worthy of a considerable amount of study by learners of TV technique.

Altogether, this book is an excellent introduction to the part of the subject which it covers. It does well what it sets out to do, in a very readable and easily assimilated style which will be found much to the liking of those who want their television without mathematics. Indeed, it makes one look forward with considerable eagerness to Volume II of the series, which is scheduled to deal with video amplifiers and the generation of special waveforms.

* * *

"Fundamentals of Electronic Motion," by Willis W. Harman. (Publishers, the McGraw-Hill Book Co. Inc.)

The author of this book is associate professor of electrical engineering at Stanford University, and in his preface declares himself as a proponent of the analytical approach to engineering. Indeed, he goes so far as to say that the book is primarily a book on analysis, and that it is about electron tubes is to some extent incidental. His approach can be gauged from a further remark taken from the preface, "Students have accused me," he says, "of offering a course in applied differential equations which masquerades under the title 'Theory of Vacuum Tubes' to lure takers. I admit to some truth in the charge."

To the author, the means used to solve engineering problems are more important than the actual solutions themselves. This is as it should be, for the advanced student is, or should be, more concerned with finding out why things are done in a certain way than with the things themselves. The book is obviously not one for the non-mathematical reader. The reader is presumed to have a knowledge of calculus, and he is taken into the realms of more advanced mathematics, which are explained as the book progresses. It should not be assumed, however, that on account of its mathematical nature the book does not concern itself with practical electronic problems. In point of fact, quite the reverse is the case. The subject-matter treats in a practical way all those developments, most of them quite recent ones, which depend on electron ballistics. These devices include not only cathode-ray tubes, in all their forms, but magnetrons, klystrons, travelling-wave tubes, cyclotrons, and betatrons. For those who want or need to know something of the fundamental working of all these, and many other electronic devices, presented at an engineer's level, this will be found an excellent text, fully in keeping with the publisher's high standard of authorship and production.

* * *

"The Student Engineer," Volume 6. Published by the Enginering Society of the National School of Engineering, Canterbury University College.

This volume of more than 160 pages is a monument to the energy and enthusiasm of the Canterbury College Engineering Society, which draws its membership wholly from within the ranks of engineering students at present carrying out their studies for B.E. at the Engineering School. It is somewhat remarkable that a student body of this sort should be able to produce such a volume at all, let alone one covering such a wide field of engineering endeavour. Some of the papers presented are drawn from those read before the society during the academic year, while others describe activities of engineers who have travelled overseas. As is to be expected, electrical, civil, and mechanical engineering are all represented, and topics range from colour television to the mechanics of air-dropping of supplies.

The book can be recommended to all those—professional or otherwise—whose interest in engineering extends beyond their own restricted field.

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Volume Level and the Ear

In the search for the illusion of perfect sound reproduction, the problems that are encountered are enough to daunt the greatest enthusiast; however, it is that little bit which is always out of reach which constitutes one of the major attractions of audio experiments. Amplifiers can be constructed or are available with extremely small amounts of overall distortion, but that in itself doesn't help much when pick-ups, speakers, and records are all busy contributing their quota of distortion, which is generally in excess of that from the amplifier.

There is also another factor which has considerable bearing on the subject, and that is the sound level at which we listen—in other words, how far up the wick is turned!

It is a common misconception that if the volume control is reduced, the whole programme decreases proportionately; this is not the case though, since our ears (with which we all have to live) have by no means a linear frequency characteristic—the low-frequency end of the spectrum falling off rapidly. Tests have been conducted with a large number of people which have shown that, in general, the sound which can just be detected at 50 cycles is some 400 db. higher than at 20000 cycles. This means in effect that the average ear is 40 db. less sensitive at 50 cycles than at 2000. In turning the volume level down, then, one would expect the bass end of the reproduction to suffer first, and this is exactly what happens. The music loses body and sounds artificial right away unless some form of correction is employed. In the case of quality, enthusiasts who have a good amplifying system, a tone-compensating network is taken for granted, and deficiencies in the programme brought about by low-volume levels can be corrected.

In a less expensive form but with the same object in view, some radio manufacturers have provided a tapped volume control on the set which automatically brings about bass lift when the volume is reduced beyond a certain point. A typical arrangement is shown in Fig. 1, and, although an inductance is included in part of the bass boosting circuit as an ideal, in practice it nearly always is a normal resistance for simplicity and economy reasons. The position of the tap on the volume control is determined with regard to the performance of the set and the likely volume level at which the set may be operated in the normal home.

Critics of this artificial bass-boosting may well say that, since the deficiency in the reproduction is a failing of our own ears, why correct for it when the real musical performance would also be lacking in bass if played at the same level—that is, very subdued. As an argument, this is true enough, but there comes a time when the most ardent enthusiast doesn't want to listen to the National Orchestra going full blast in his drawing-room and so the volume level is reduced. Would he, then, be content to sit and listen to the music with its obvious failings or would he

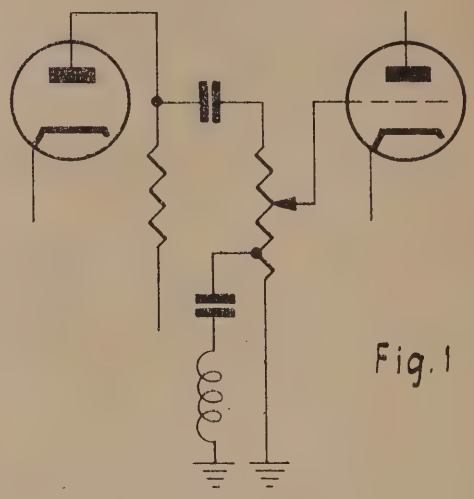
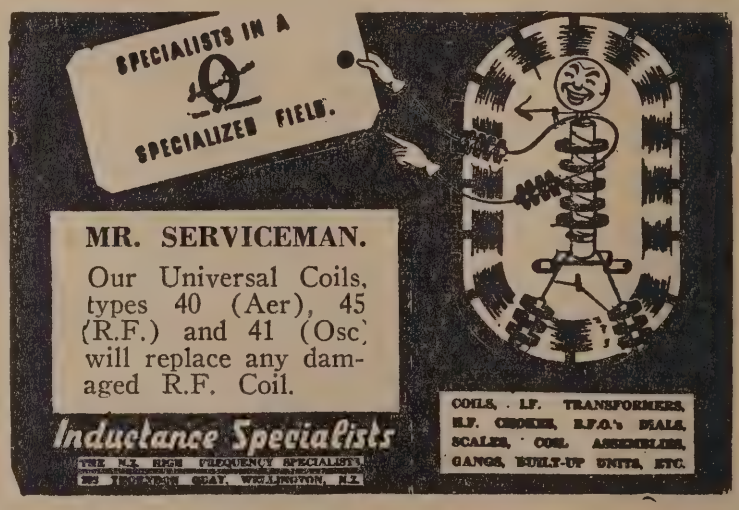


Fig. 1

rather introduce a bit of artificial boom-tiddy-boom for the sake of pleasant listening? Most of us have already decided, and have that bass control well advanced.

So far, no bright boy has come to light with an idea for improving the frequency response of our ears, but possibly future generations of men will be born with high-fidelity ears; it will be just too bad if a multicellular horn becomes part of our necessary hearing aids!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INTRODUCTION

Readers of the "Experimenter" are familiar with the Philips double tetrode which goes by the number QQE06/40. It was the valve used in the output stage of the 100-watt transmitter whose description we ran serially through these pages a few years ago, and which created considerable interest in amateur circles. This valve, it will be remembered, is electrically equivalent to the American 829B in most respects, but differs from it very markedly as far as high-frequency performance is concerned. The 829B is rated for service at reduced ratings up to 250 mc/sec., but the Philips QQE06/40, whose performance at lower frequencies is identical, has the very great advantage of being able to operate at frequencies as high as 500 mc/sec. Not only does this ability open up new fields of application, but it also means that at lower frequencies, at which both tubes will work, the efficiency of the Philips valve must be considerably greater.

Another American valve which has found wide acceptance for V.H.F. applications is the 832. This is a double tetrode, similar in conception and in structure to the 829B, but with smaller plate dissipation, and therefore suitable for lower-powered applications. The Philips range has also included for some years a valve electrically equivalent to the 832, called the QQE04/20. This valve, however, did not represent the degree of improvement over the 832 that the QQE06/40 does over the 829B.

A NEW 832 "EQUIVALENT

Because there is clearly a need for a smaller version of the QQE06/40, to take care of low-powered applications, the Philips valve laboratory has developed the QQE03/20, and although its type number is very similar to that of the older valve, its construction and performance are quite different. Most noteworthy is the fact that this valve, too, is able to work up to much higher frequencies than either the 832 or its other equivalent, the QQE04/20. The new valve gives useful output up to frequencies as high as 600 mc/sec.—even higher than the QQE06/40 will go. The valve is built in exactly the same way as the QQE06/40, with a large double-sided cathode, a screen grid that is common to both halves, and large tantulum-coated plates supported only at the seals at the top of the valve. The Philips sintered-glass base has been used, as before, but the use of sintered glass has been extended to the top of the bulb, which is also of this material.

As a result of these constructional features, there are virtually no separate cathode or screen-grid leads for the individual sections of the valve. This is one reason why such excellent U.H.F. performance has been attained, since in a balanced push-pull system such as a valve of this type makes, R.F. currents from the two sections cancel out in the common cathode and screen-grid leads. These currents can not then set up negative feedback which would be detrimental to V.H.F. and U.H.F. performance.

Another feature of the QQE03/20 that has been "borrowed" from the QQE06/40 is the use of built-in neutralizing condensers. These take the form of small lengths of wire welded to the control-grid supports at the top of the valve. They are so placed and proportioned that their capacities to the plate leads of their opposite valve sections are exactly equal to the sections' grid-to-plate capacities. They thus form a built-in cross-neutralizing system which inherently possesses wide-band characteristics. As a result, there is no necessity for external neutralizing circuits, even at the upper frequency limit of operation, provided only that feedback cannot occur through imperfect shielding between the input and output circuits external to the valve.

LOW INTER-ELECTRODE CAPACITIES

Another advantage which the QQE03/20 possesses over the 832 is the smallness of its inter-electrode capacities. The input capacity of each section is only 6.5 $\mu\mu$f., as against 8 $\mu\mu$f., and the output capacity is only 2 $\mu\mu$f., as against 3.8 $\mu\mu$f. When used in push-pull, as the valve will certainly be in most applications, the grid-to-grid input capacity is 4 $\mu\mu$f., and the plate-to-plate output capacity is 1.3 $\mu\mu$f. From these figures, it can readily be seen that, particularly at high frequencies, it must possess a considerable advantage, since the effectiveness with which long lines can be used as circuit elements is much greater the smaller the capacities that are connected across their ends.

PERFORMANCE

To illustrate the excellent performance of this valve we can hardly do better than list some of the typical operating conditions as a Class C amplifier and frequency tripler. These lists show very well the low-driving requirements, excellent efficiency, and substantial power output of the QQE03/20.

CHARACTERISTICS

Heater voltage: 6.3 or 12.6.

Heater current: 1. 3 or 0.65 amps.

Input capacity: per section, 6.5 $\mu\mu$f.; in push-pull, 4.0 $\mu\mu$f.

Output capacity: per section, 2.0 $\mu\mu$f; in push-pull, 1.3 $\mu\mu$f.

Grid/screen amplification factor (at plate current of 40 ma.), 8.5.

Mutual conductance (at plate current of 40 ma.), 2.4 ma/v.

OPERATING CONDITIONS

Class C Telegraphy:

Frequency	200	200 mc/sec.
Plate voltage	600	200v.
Screen voltage	250	200v.
Grid bias	—60	—30v.
Plate current	2 × 50	2 × 50 ma.
Screen current	8	8 ma.
Grid current	2 × 0.7	2 × 1.0 ma.
Plate input	2 × 30	2 × 10 watts
Plate dissipation	2 × 9	2 × 4 watts
Screen dissipation	2	1.6 watts
Driving power	3	1 watt
Output power	42	12 watts
Efficiency	70	60%
Frequency	400	600 mc/sec.
Plate voltage	400	300v.
Screen voltage	250	250v.
Grid bias	—50	—40v.
Plate current	2 × 50	2 × 50 ma.
Screen current	6	4.6 ma.
Grid current	2 × 1.0	2 × 0.6 ma.
Plate input	2 × 20	2 × 15 watts
Plate dissipation	2 × 9	2 × 9 watts
Screen dissipation	1.5	1.4 watts
Driving power	4	— watts
Output power	22	12 watts
Efficiency	55	40%

Class C Telephony (plate and screen modulation):

Frequency	200	400 mc/sec.
Plate voltage	500	300v.
Screen voltage	250	250v.
Grid bias	—55 to —100	—40 to —60v.
Plate current	2 × 40	2 × 40 ma.
Screen current	8	6 ma
Grid current	2 × 0.5	2 × 1.0 ma.
Plate input	2 × 20	2 × 12 watts
Plate dissipation	2 × 6.5	2 × 5.5 watts
Screen dissipation	2	1.5 watts
Driving power	2 × 2.5	— watts
Output carrier power	27	13 watts
Efficiency	67.5	54%

Class C Frequency Tripler:

Frequency	66.7 to 200	133 to 400 m/s.
Plate voltage	300	300v.
Screen voltage	250	250v.
Grid bias	—180	—180v.
Plate current	2 × 45	2 × 45 ma.
Screen current	5	5.6 ma.
Grid current	2 × 1.0	2 × 1.2 ma.
Plate input	2 × 13.5	2 × 13.5 watts
Plate dissipation	2 × 9.5	2 × 10 watts
Screen dissipation	1.26	1.4 watts
Driving power	2	4 watts
Output carrier power	8	7 watts
Efficiency	42	35%

From the above figures, the excellent performance of the QQE03/20 in the upper V.H.F. and lower U.H.F. regions of the spectrum will be readily appreciated, For example, an efficiency of 35 per cent. while tripling from 133 mc/sec. to 400 is really remarkable, and it is doubtful whether any other valve of similar size will work as well at such frequencies. Similarly, 40 per cent. efficiency as a straight amplifier at 600 mc/sec. is excellent, too. The only difficulty to be met with in obtaining such performance is that of building suitable tuned circuits at such high frequencies. However, the great advantage of such a valve over, say, disc-seal or "lighthouse" tubes is that the latter require coaxial circuits which are difficult and expensive to make, whereas the QQE03/20 is suitable mechanically for open-wire types of tuning line. As we shall see in the second part of this article, operation in the 120 to 460 mc/sec. amateur band is very easy to secure, with a minimum of constructional effort, and with very few commercial components. In fact, given the valve and its socket, the remainder of the "works" consist of simple rods and wires that can be fabricated in even the most modest amateur workshop.

SOME OPERATING POINTERS

It will be noted that the above tables give no clue as to how grid bias is obtained, merely quoting the grid current and bias voltage. This is done in order to allow the user to please himself just how that bias is obtained. For example, it can be the conventional sort of grid-leak bias, if desired, or it can be ordinary cathode bias, or a combination of the two. Now this is a matter which seems to give some amateurs a certain amount of difficulty, and since the correct operating conditions are even more important at very high frequencies than at lower ones, it would not be out of order perhaps to enlarge a little on it at this point. We were asked quite recently how to work out from the published valve figures the required grid and cathode resistors to give a certain proportion of grid-leak bias to cathode bias. This is how it is done. We need a certain amount of bias on the grid, together with a specified amount of grid current. At the same time, the list of operating conditions tells us what the plate and screen currents should be under the chosen set of conditions. Suppose, then, that we are working on the left-hand list under the heading of Class C Telephony. The total cathode current is thus 2 × 40 (plate) + 8 ma. (screen), making 88 ma. in all. We want to use just enough cathode bias resistance to limit the cathode current to a safe value in the event of the drive failing. In the absence of curves, we can estimate the cut-off bias by dividing the screen voltage by the grid/screen amplification factor. This gives us 250/8.5 = 29.4 volts. Now, a safe value of cathode current will result if we make the cathode resistor such that, under working conditions, the bias produced is equal to the cut-off bias, say, 30v. We know that the working cathode current will be 88 ma., so that by Ohm's Law, we find that the required cathode resistor will be 30/0.088 = 340 ohms. The nearest preferred value is 330 ohms, which will actually give 29 volts bias. We thus have 29 volts of cathode bias under working conditions, so that, whatever the total grid bias has to be, the remainder of it must be provided by other means. In our case, let us suppose that we are to use the maximum recommended bias of 100 volts. This leaves 71 volts to be provided, either by means of fixed bias, or by grid biasing. If we choose to use the latter, then we have a grid current of 1 ma. which, flowing in the common grid leak, must give 71 volts drop across it. This necessitates a leak resistor of 71k., so we can use a 68k. resistor and achieve a total bias

(Continued on page 48.)

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A NEW SERIES OF MINIATURE BATTERY VALVES

SWAN ELECTRIC CO. LTD. ANNOUNCES A NEW SERIES OF MINIATURE BATTERY VALVES FEATURING AMAZING BATTERY ECONOMY

It would be excusable for anyone to believe that in the standard series of miniature battery valves the ultimate in battery economy has been reached, but a recent announcement by Swan Electric Co. Ltd., New Zealand distributors for Pope valves, shows that such is not the case. The news referred to is of an entirely new series of miniature battery valves, known as the Pope D-96 series, in which substantial savings have been effected in both filament and H.T. power, with almost no sacrifice in performance. This new Pope D-96 series is now available in New Zealand.

LOW FILAMENT DRAIN

The most startling difference between the new Pope series and the older one is that the former has exactly half the filament current of the latter. Of the four new types, the DK96 is a heptode oscillator-mixer tube, which is intended to replace the DK92 or the 1R5 in new set designs. Its filament draws only 25 ma. at 1.4 volts, and it has the added advantage of possessing a separate oscillator anode electrode, making it easier to apply than the other types mentioned, since the screen-grid no longer has to do duty as the oscillator plate as well.

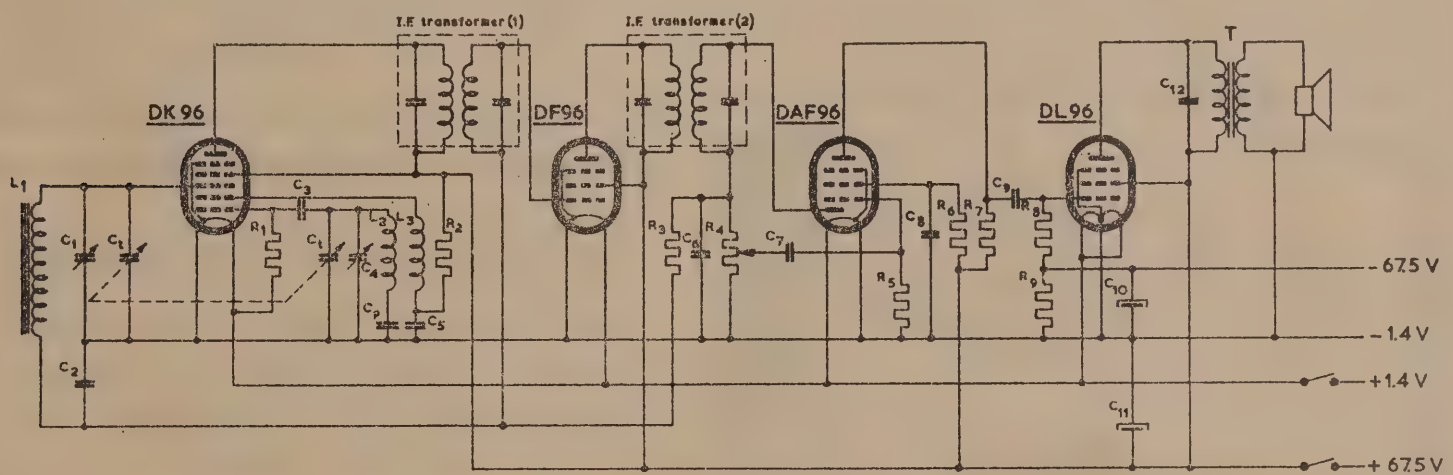
The DF96 is an R.F. pentode, designed to replace the DF91 or 1T4, and also with a filament current of only 25 ma. at 1.4 volts. The saving is effected without any loss of mutual conductance, which means that R.F. and I.F. stages using this valve will have just as much gain as with the previous types, in spite of the smaller filament current.

The DAF96 replaces the DAF91 or 1S5. Its pentode section will give substantially the same stage gain as an A.F. amplifier as the valve it replaces, and yet it, too, takes only 25 ma. filament current.

The power valve of the series, like the DL92 or 3S4 which it is intended to replace, has a centre-tapped filament so that it can be used with either 3 or 1.5v. filament batteries, takes 50 ma. with the series connection, at a nominal voltage of 2.8, or 25 ma. with the parallel arrangement, fed from 1.4 volts. This is the only valve of the new Pope series which can be said to differ appreciably from the others in characteristics. With an H.T. voltage of 90, it requires a load impedance of 13,000 ohms, to which it will deliver a power output of 200 milliwatts. This can be compared with the 270 milliwatts produced in an 8000-ohm load by the DL92. The output of the DL96 is certainly smaller, but so, too, is its H.T. drain—5.9 ma. as against 8.8 ma. for the DL92. In practice, the difference in sound output would be very slight, because it would be no more than 2½ db., and 2 db. is about the smallest change in level that can ordinarily be distinguished by the ear.

OVERALL ECONOMY

To give some idea of the current reduction to be obtained by the use of the Pope D96 series, it can be pointed out that a four-valve receiver using these valves would have exactly half the filament consumption of the older-type valves, and with a 90v. H.T. drain would be reduced from 13.4 to 10.5 ma. With radio batteries at their present prices, such savings can hardly be sneezed at!



COMPONENT LIST

R_1, 27k.
R_2, 18k.
R_3, 1.5 meg.
R_4, 0.5 meg. Pot.
R_5, 4.7 meg.
R_6, 3.3 meg.
R_7, 1 meg.
R_8, 2.2 meg.
R_9, 380 ohms.
L_1, loop or rod aerial coil.
L_2, L_3, oscillator coil.
C_1, C_4, trimmers.
C_2, 0.1 μf.
C_3, C_6, 100 μμf.
C_5, C_8, 0.05 μf.
C_7, C_9, 0.01 μf.
C_{10}, 25 μf. 25v. Electro.
C_{11}, 16 μf. Electro.
C_{12}, 0.002 μf.
C_t,, two-gang condenser, to suit coils used.
C_p, padder condenser, to suit coils used.

An interesting and useful feature of the DF96 and DAF96 is that their electrical characteristics are so similar to those of the DF91 and DAF91 that they can be used as direct replacements in battery sets, effecting a current saving of approximately 25 per cent. without any changes in the set or to its performance.

A CIRCUIT FOR THE NEW VALVES

The sole New Zealand distributors of Pope valves, Swan Electric Co. Ltd., submit the accompanying diagram showing a typical circuit for a four-valve personal portable using the new Pope series. It features a loop or rod aerial, whichever is preferred, and can be seen to embody no revolutionary features except the low-filament current, which does not show on the circuit diagram, unfortunately, and runs from an H.T. of 67½ volts. The output transformer should match the voice-coil to 15,000 ohms. With this H.T. voltage, the power output is 100 milliwatts.

The extremely low drain of these Pope valves will certainly appeal to the professional and amateur set-builder alike, and will make it possible to experiment with many unconventional arrangements which hitherto could be entirely ruled out on the score of battery drain alone.—P.B.A.

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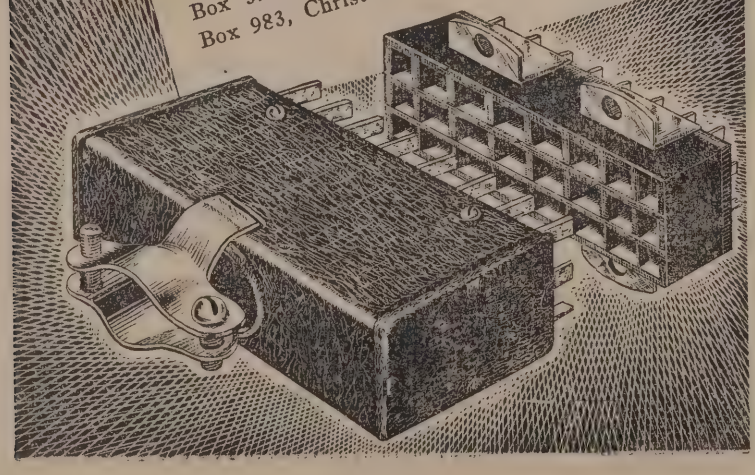

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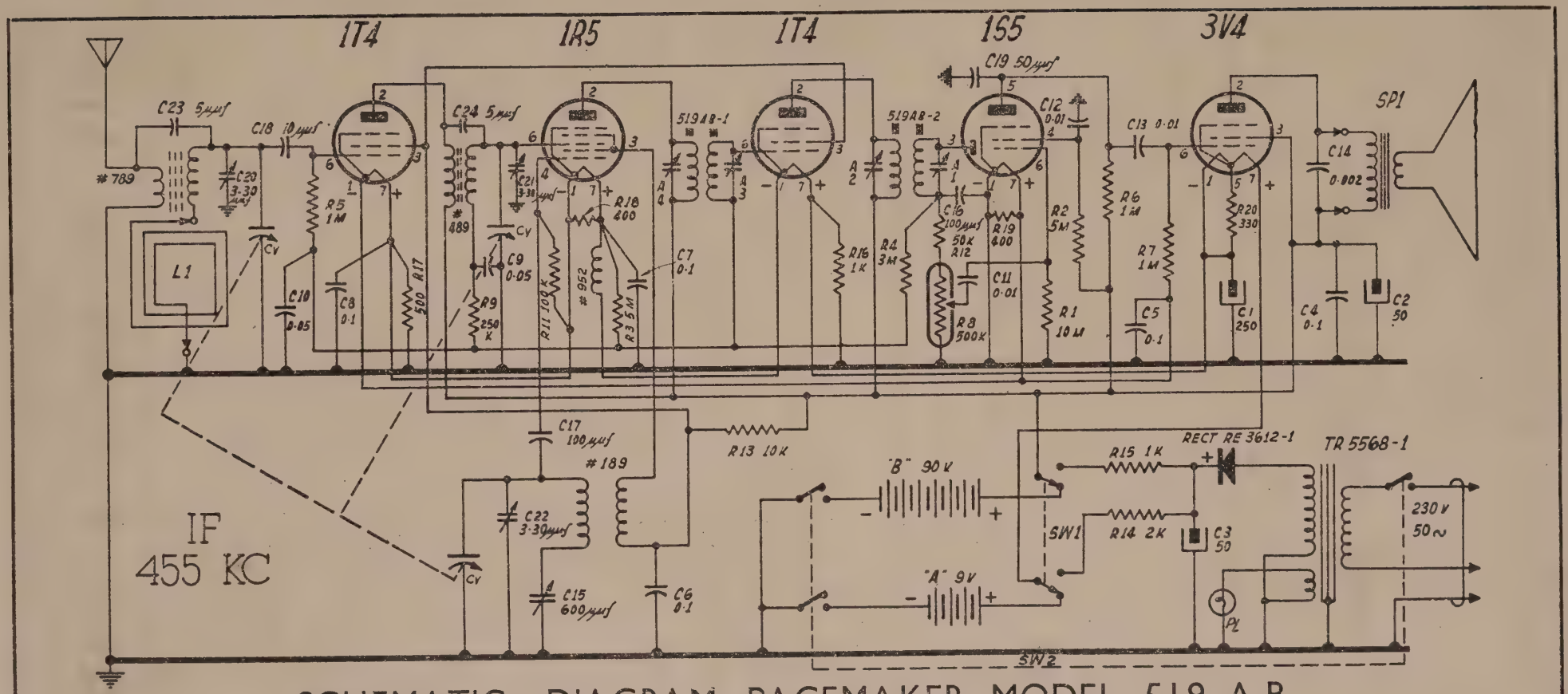

SCHEMATIC DIAGRAM PACEMAKER MODEL 519 A.B.

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	1T4	1.4	90	50	—	1.4	0	2.7	
Conv.	1R5	2.7	90	50	-8	2.7	0	4.2	
I.F.	1T4	4.2	90	50	—	4.2	0	5.6	
Det-AF.	1S5	0	—	0	12	10	0	1.4	
Output	3V4	5.6	86	90	90	6.8	0	8.1	

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	1T4	*	3K	13K	—	*	4.5meg.	*	
Conv.	1R5	*	3K	13K	100K	*	3.5meg.	*	
I.F.	1T4	*	3K	13K	—	*	3.5meg.	*	
Det-AF.	1S5	0	—	.55meg.	5meg.	1meg.	10meg.	*	
Output	3V4	*	3K	3K	3K	*	1meg.	*	

1. D.C. voltage measurements are at 2,000 ohm per volt—A.C. voltage measurements at 1,000 ohm per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative.
4. Nominal Tolerance on component value make possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to condition of filter capacitors.
7. Voltage and resistance readings taken in A.C. position.
   * Do not use ohmmeter to measure filament resistance.

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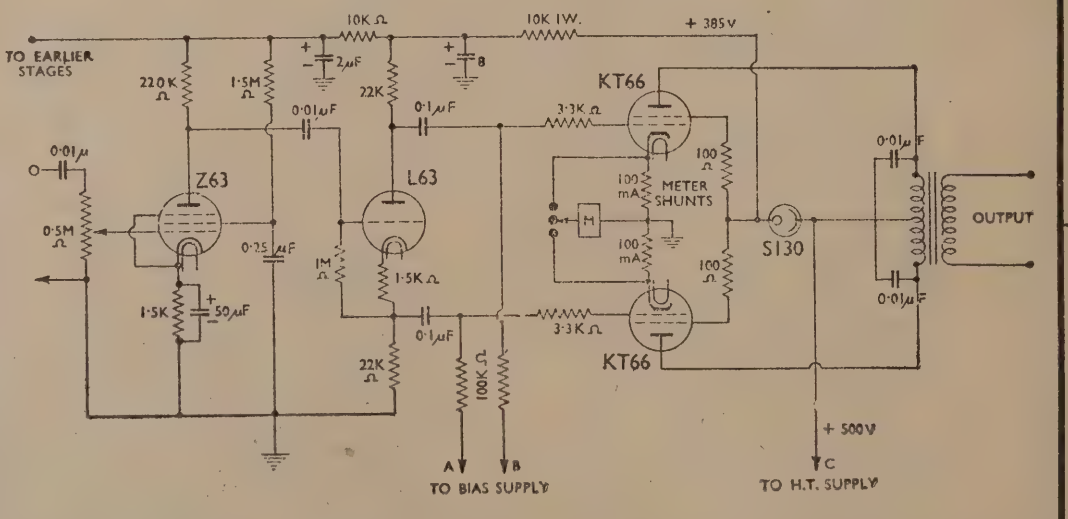
The KT66 is very robust, both electrically and mechanically, hence it is suitable for many industrial applications.

Typical circuit of 50W class ABI amplifier



Write for data on the KT66 to: Osram Valve & Electronics Dept.

BRITISH GENERAL ELECTRIC CO., LTD.

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MOPA Transmitters

(Continued from page 15.)

ment employed can be much more profitably altered to that of Fig. 5, with the consequent saving of a coil and condenser.

It is advantageous to employ high-slope triodes in both positions in this circuit; where they are not available, high-slope short-grid base-type pentodes, triode-connected, may be substituted.

In conclusion, the theoretical design of a three-stage MOPA transmitter published in the late 1930s

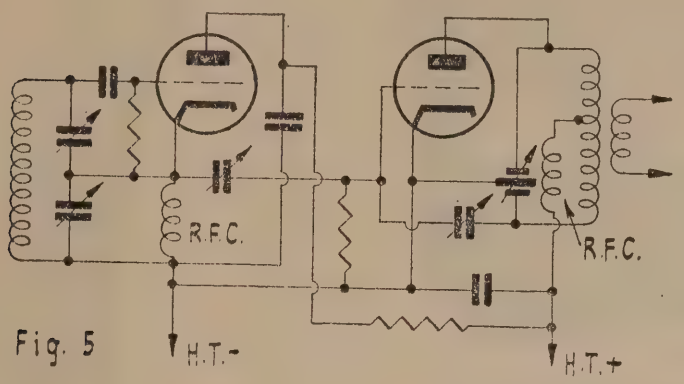

Fig. 5

On the face of it, the circuit shown appears reasonable in every respect; however, it was at once evident that when the 47 buffer anode circuit was tuned to the same frequency as the oscillator anode circuit that T.A.T.G. oscillations were taking place. The case of the output stage was proportionately worse, due to the parallel operation of the two 47s there. In Fig. 7, note the omission of the bypass capacities across the grid leaks of the buffer and final stages. Also the altered values of the coupling and the addition of neutralization as already outlined. The method of neutralization adopted is not the best, as also previously explained, but holds sufficiently well over a swing of some 200 kilocycles either side of the centre frequency.

Other features are the use of a wire-wound potentiometer for setting the screen voltage for optimal stabilization against H.T. power supply output voltage changes and the inclusion of control and screen grid "stopper" resistors.

Finally, it should be appreciated that there is no particular merit attached to the use of the valves shown, and any with similar characteristics might be employed. Suitable alternatives would be a 6SJ7 or 6AC7 into 6V6s or 6L6s; again, an 802 and 807s would do.

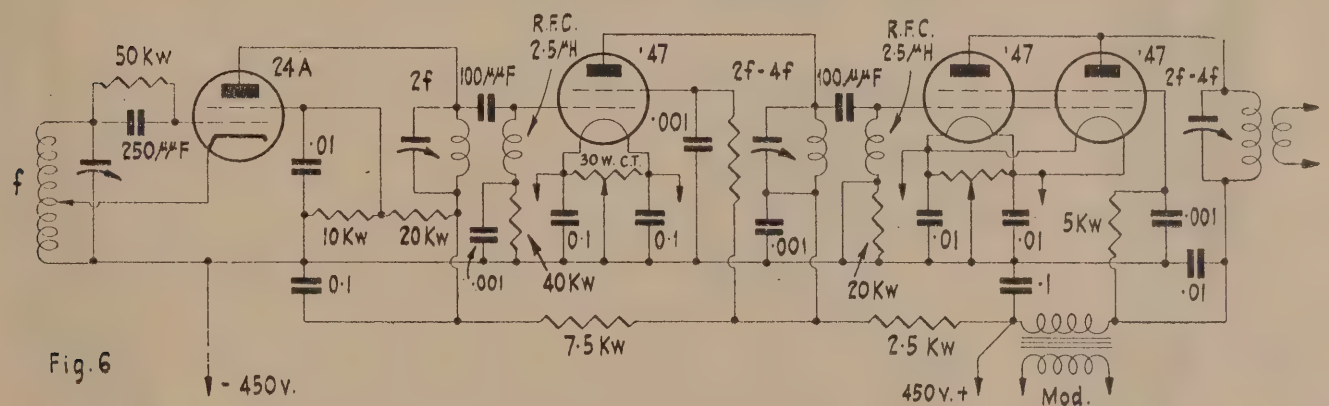

Fig. 6

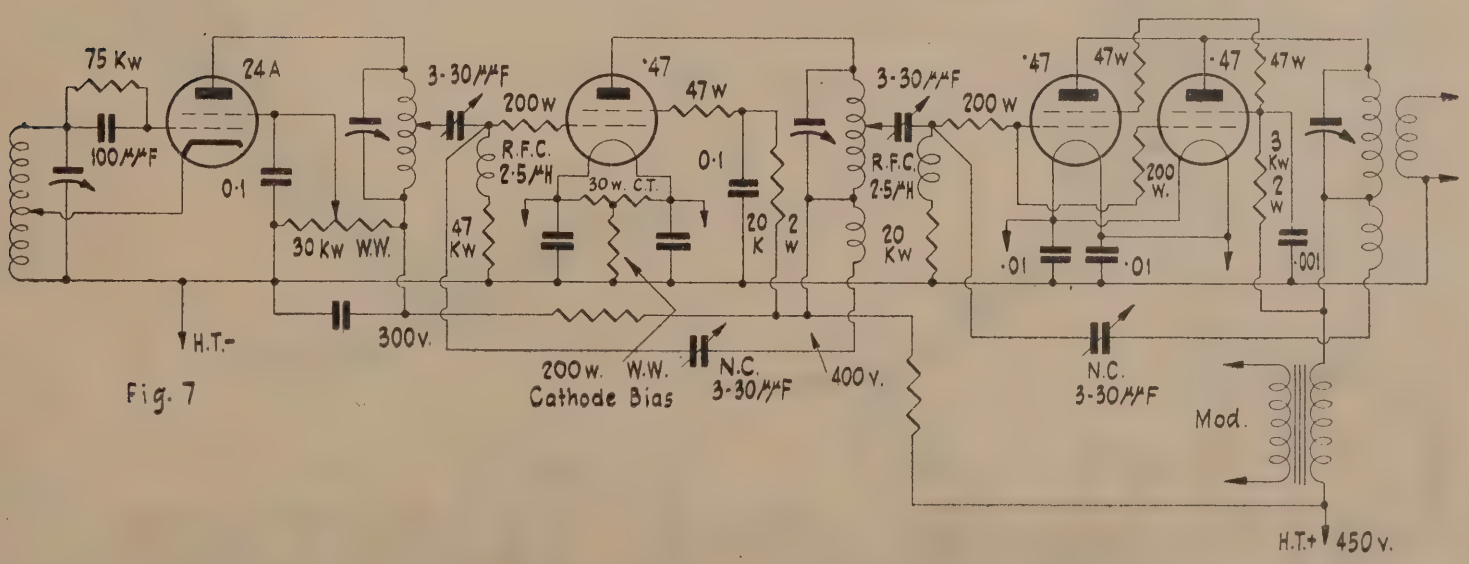

Fig. 7

is shown complete with component values, and below it again is the circuit shown with the modifications found necessary to enable stable telephony operation to be achieved.

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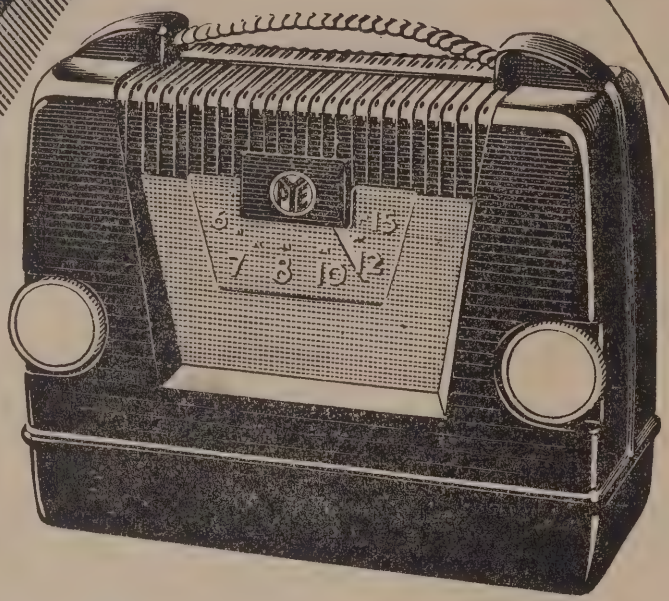

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P34

Magnetic Amplifiers

(Continued from page 12.)

By so doing, the gain can be made almost infinite, but when this happens, the whole thing acts not as a normal amplifier, but as a trigger circuit. With this kind of operation, a vanishingly small control current can cause the load current to jump from zero to a very high value. This represents instability, of course, but when it is controlled, by a suitable proportioning of the windings, it can be very useful. It is ideal, for example, when the load device is a relay or contactor which must be either on or off. It turns out that there is a very simple relationship between the numbers of turns on the various windings, which enables one to ensure that the transductor is worked below the instability point. Indeed, the only limitation to the degree of amplification obtainable in a magnetic amplifier is the stability with which one can control the various currents that are to be used.

For instance, suppose the transductor whose curve is illustrated in Fig. 4 (b) is to be operated as a linear amplifier, like a Class A valve amplifier, it will be necessary to bias it to the middle of the straight portion of its curve. This can be done in two ways. Either we can put a certain standing current through the control winding to bring the operating point to the middle of the curve, or we can put on a separate winding and pass a biasing current through it. This is useful when we want linear amplification of a direct current which can have positive, zero, or negative values—i.e., it can change in either direction.

From the above, it can be appreciated that a transductor can, and usually does, have a rather large number of windings. In practice, however, there are only three basic windings—the load, control, and feedback windings. To these can be added a bias winding, making a fourth. In practice, too, all these windings can have each half split into a number of different sections. By interconnecting these in different ways, it is possible to make considerable changes in such things as the input and output impedances of the amplifier. Indeed, it is as though we had a valve in which we could alter the spacings between the different electrodes at will, and produce any desired characteristics, simply by making the necessary adjustments.

Before we leave transductors, it should be pointed out that there is yet another kind. The one we have just discussed is called the separately self-excited transductor. In case this should sound contradictory, it should be pointed out that the term self-excitation refers to the use of feedback, by rectifying the load current. The word "separately" indicates that a separate winding is used through which to pass the feedback current. In the remaining type, with the rather horrid name of "auto-self-excited transductor," the "auto" part means that the self-excitation is obtained by passing the rectified current through the same windings which carry the A.C. load current. As a little thought will show, to do this requires a good deal of ingenuity. In practice, it is accomplished by means of a separate set of metal rectifiers, so connected that the D.C. through the load windings flows always in the right direction to aid the control winding in saturating the core.

PRACTICAL RESULTS

In a future article, it is hoped to present some practical data showing how working models of magnetic amplifiers can be made, provided only that some small mu-metal laminations, some winding wire, and some small rectifiers are available. The subject is a fascinating one, and even the amateur radio man should not be at a loss for applications of this interesting new device.

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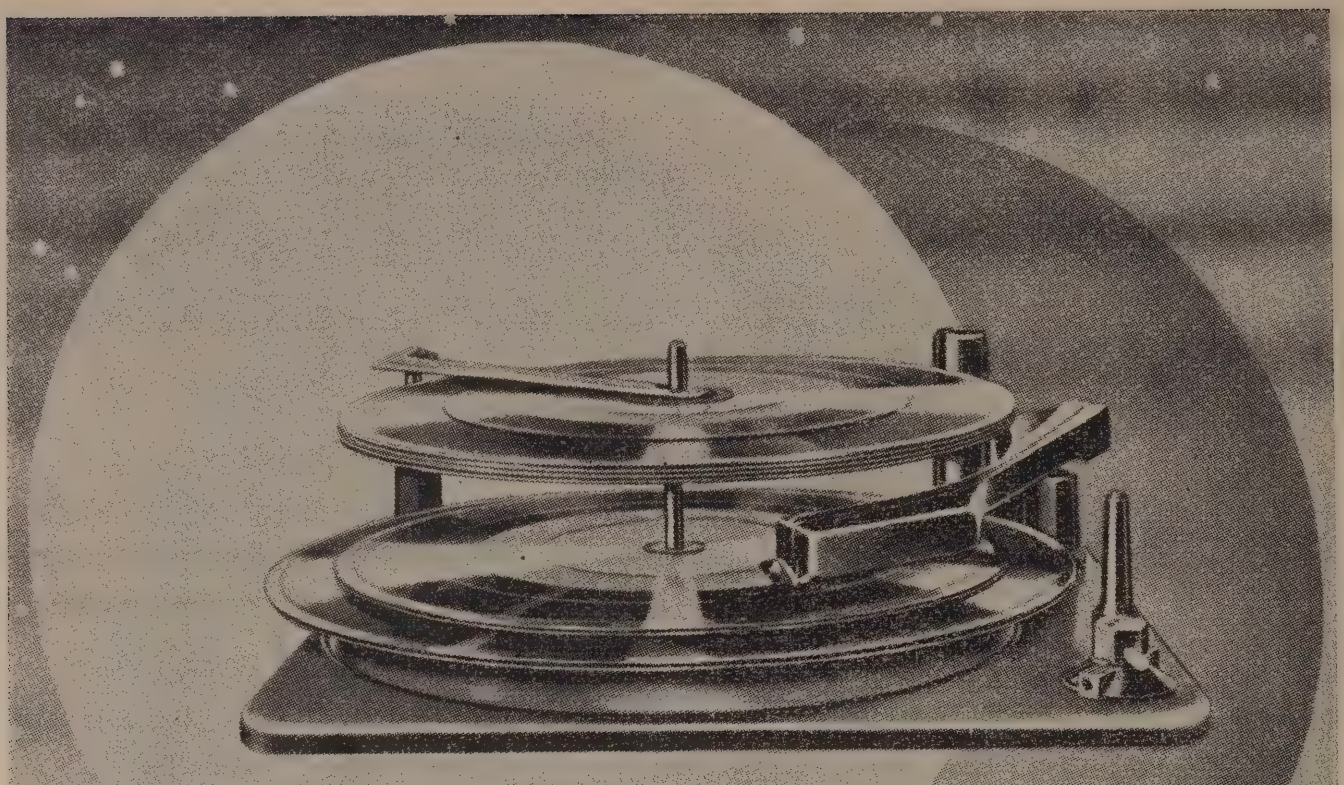

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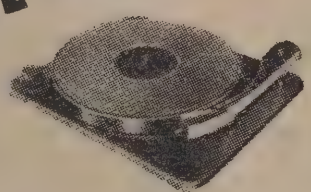

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DISCOVERY OF PERLITE IN NEW ZEALAND

Congratulations of all members of the radio and electrical trade go to Mr. B. T. Giles, of Messrs. Giles & Elliott Ltd., Wellington, on his discovery of large perlite deposits in New Zealand.

Always to the fore in new developments, Mr. Giles was one of the first importers of a new radiant heating cable in New Zealand, having realized its potentialities during his service with the Navy in World War II.

Satisfactory though this cable proved to be, the loss of heat through the walls, floors, and ceilings of the rooms heated caused concern. Determined to overcome this problem, however, Mr. Giles searched for some reasonably economic form of thermal insulation for use in conjunction with radiant heating.

Perlite, he decided, was the answer, but this, alas, was available only from dollar sources, and shipping costs were exorbitant, amounting to 20 times the cost of the product. To the undaunted Bernie, however, perlite was still the answer, and, knowing of its volcanic origin, he hazarded a guess at its presence in the volcanic areas of New Zealand.

Reference to geological publications revealed allusions to perlitic rhyolite, which it was thought might prove to be perlite. Therefore, accompanied by Mr. C. S. McCabe, and assisted by Mr. B. Thomson, a Government geologist at Rotorua, Mr. Giles spent many week-ends, much money, and tremendous energy searching large areas of the countryside. The quest was complicated by the fact that the prospectors had no means of recognizing this mysterious mineral other than the fact that, when crushed and heated above 1500 deg. F., it "popped" into tiny glass globules. Always inventive, however, Mr. Giles soon devised a method of testing samples in the field, and, though test after test failed to produce results, the search continued with unabated enthusiasm, until one day a piece of rotten rock, tested more through habit than in hope, suddenly exploded into a myriad tiny globules. Perlite had been found! Later, large sources of supply were discovered, and a company has now been formed to produce perlite for local use and possibly for export.

After crushing, the rock dust is blown into a special retort, exploded by heat, and blown out of the other end as commercial perlite. Material for particular purposes can be produced by controlling the amount of expansion. Though greater expansion can be obtained for other purposes, that for thermal insulation is about ten times by volume.

Only one-tenth the weight of sand and aggregate in concrete, the processed perlite, when used in concrete, not only lessens the fire hazard through its glass properties, but also insulates and reduces the weight of the building, thus automatically decreasing the amount of steel required for reinforcing.

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TRADE WINDS

A recent most welcome visitor to New Zealand has been Mr. Bruce Harbort, general manager of Rola Co. (Aust.) Pty. Ltd. With more than 20 years of Rola service to his credit, during the last ten of which he has been general manager, Mr. Harbort has been paying a goodwill visit to this country, and taking the opportunity of conferring with some of the larger manufacturers in Wellington and Auckland. He has been most impressed with the manufacturing progress achieved by his firm's New Zealand subsidiary, Loudspeakers (N.Z.) Ltd., since its formation only twelve months ago, and has confidently assured New Zealand manufacturers that they can be sure of securing in this country the very best Rola products available.

* * *

H.M.V. STAFF CHANGES

To cope with the ever-increasing technical problems of the H.M.V. organization in New Zealand, and ensure that high standard of service for which this firm is so justly proud, Mr. L. H. Wright has been appointed Technical Manager. Actually, this is no new appointment, as, in addition to his duties as Manager, Mr. Wright has been looking after the technical side of the business for some considerable time. Now developments have reached such proportions that it is necessary for him to devote all his time to this work.

The former Assistant Manager, Mr. S. Heginbotham, has been appointed Manager.

We wish Mr. Wright and Mr. Heginbotham every success in their new appointments.

* * *

NEW FACTORY FOR DOMINION RADIO & ELECTRICAL CORPORATION LTD. AT HUIA ROAD, OTAHUHU

Having been approved by the directors of Dominion Radio and Electrical Corporation Ltd. and Philco International, the plans for the former company's new plant at Huia Road, Otahuhu, are nearing completion, and earthworks and ground lay-out have commenced already.

This most progressive firm announces that all its activities will be housed in this modern factory situated on eight acres of ground. Planning for the future, Dominion Radio and Electrical Corporation has provided for the manufacture of television receivers, and, as the site is in an "interference free" area, conditions should be most favourable for this new field of endeavour.

We congratulate Dominion Radio and Eleectrical Corporation on its foresight, and wish it every success in this big undertaking.

C. R. PEOPLES & CO. LTD.

Expansion and modernization seem to be the keynotes of the radio industry these days. Last month, our roving reporter scrambled under ladders and over boards to reach the offices of that popular member of the radio industry in Auckland, C. R. Peoples & Co. Ltd. Now comfortably installed in efficient and modern offices, this firm will continue to give that excellent service for which it has earned such a good name.

GEORGE WOOLLER & CO. LTD.

Always abreast of modern developments, this well-known Auckland firm now welcomes clients into its newly-painted and extremely modern offices in Chancery House. Renowned for good service and courteous staff attention, George Wooller & Co. Ltd. is now organized on the most modern lines to ensure first-class and prompt attention to all clients' requirements.

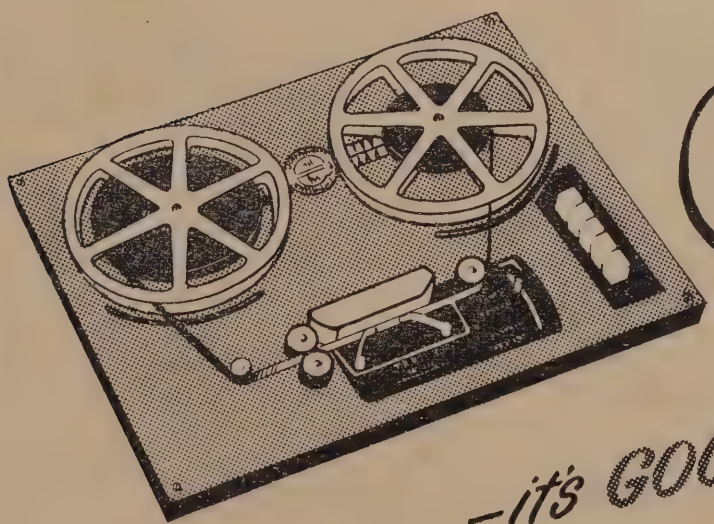
RADIO (1936) LTD.

Staid exterior walls of a large building in Quay Street, Auckland, give no hint, apart from the name, Radio (1936) Ltd., of the veritable wonderland in production which lies behind. Here a staff of some hundreds is engaged in the manufacture of a vast variety of electrical and radio goods, the quality of which is attested by the well-known trade mark of "Ultimate."

Here is something to delight every modern labour-saving-minded housewife in the beautifully fashioned electric jugs, coffee percolators, toasters, stream-lined and thermostatically controlled irons, ranges, and rangettes, to say nothing of that useful little Minichef. Coming off the production line also are heaters, space heaters, radios (large and small), and radiograms of such quality and attractive appearance that the choice of model is indeed a difficult one.

In the different production bays, modern plant cuts, fashions, and assembles the metal parts. Newest processes are used in the plating baths and the application and baking of the enamels. Skilled hands wind coils, guide the machinery used to produce all kinds of intricate and necessary components and manufacturing parts, assemble, and finally test the finished product. Skilled brains, too, direct the designing of all equipment, the laboratory work, and the vast amount of research so necessary in a plant of this nature, which keeps to the forefront of all modern developments.

Indications are that even the present enormous floor space occupied by Radio (1936) Ltd. will soon prove insufficient for the many activities of this progressive firm, whose products have shown the high standards of manufacture which can be attained in this country.



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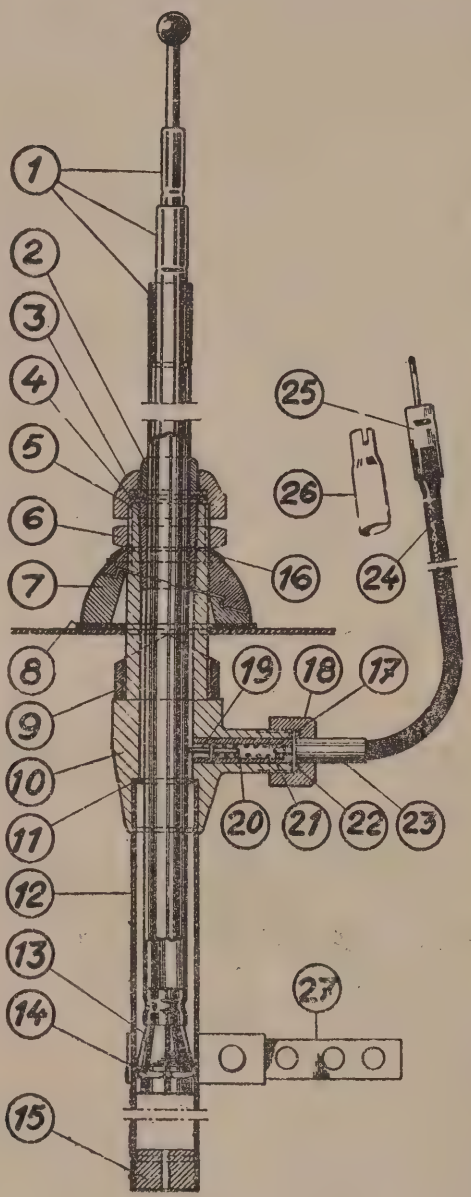

- Engineered to overcome all weaknesses, mechanical and electrical, previously encountered in car aerials.
- Finished in high-quality high-lustre chromium plate, in harmony with the finest cars on the road.
- Patented features and skilled workmanship set an entirely new standard in efficiency, durability and appearance.

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ABSTRACT SERVICE

AUDIO EQUIPMENT AND DESIGN:

The article deals with a means of testing sound reproduction by means of a light pattern which is formed by reflection from the modulated grooves of a recorded tone-disc. A new apparatus for measuring the width of the patterns is described and the errors in disc surface and focal plane measurements found when using it are compared.

—Proceedings of the I.E.E. (Eng.), Part III, July, 1953, p. 217.

Details of a commercial folded horn enclosure—the "E.V."—which can be used with any high-quality 15 in. loudspeaker system. The unit is designed to a standard lowboy height of 29 in. The two sides of the cabinet, along with the floor and adjacent wall, form a complete horn, only the cabinet side of which is slightly compromised. Thus, very satisfactory extended bass is achieved at good levels.

—Radio and Television News (U.S.A.), Aug., 1953, p. 50.

A further article on the electrical synthesis of musical tones. It deals largely with intermodulation between tones from various sources, and coupling effects in electronic circuits, the suitability of commercially-made loudspeakers as sources of sound, especially in relation to their power. If the costs of manufacture are of no consequence, extremely satisfying synthesis of sound can be achieved by electronic methods, but it is only in the organ world that such have been justified—and at present it is only the organ type of tone that has made progress.

—Electronic Engineering (Eng.), September, 1953, p. 370.

CIRCUITS AND CIRCUIT ELEMENTS:

The theory and design of cathode-follower output stages: the article deals especially with those circuits where an output is required to go both positive and negative with respect to earth. Procedures are given for choosing the most suitable valve and then proceeding to a final design so that the maximum anode dissipation for the valve is not exceeded.

—Ibid., p. 386.

Trouble-shooting high-voltage supplies: nowadays 15 kilovolts are quite usual with the bigger picture tubes, and often flyback transformers of special design are used with a damping diode to catch the unwanted oscillations. Notes are given on servicing these circuits.

—Radio and Television News (U.S.A.), Aug., 1953, p. 48.

ELECTRONIC DEVICES:

New techniques in radio astronomy: the earth's atmosphere is transparent to light, certain infrared bands, and to radio wavelengths between 1 cm. and 20 meters, but is opaque to other wavelengths. These transparent bands are the windows in our atmosphere through which radiation can be received from outer space. A new radio telescope was completed last October at the Ohio State University, which consists of a broadside array of 48 right-handed helical beam antennas on a screen 160 feet long. This very formidable array is used for picking up for analysis the waves from outer space. Interesting notes are given on the development of this branch of science.

—Electronics (U.S.A.), September, 1953, p. 148.

INSTRUMENTS AND TEST GEAR:

The vectorscope indicates the phase between two alternating voltages by the angular displacement of a radial beam emanating from the centre of the display. The circuit uses the principle that when two signals of the same frequency but of different phase are mixed in an electron tube, the tube current will contain a component that is a function of the phase angle between the two signals. The instrument is most useful in the design of phase shift filters, delay lines, phase modulation systems, and direction finders.

—Ibid., p. 180.

A method is given of converting the conventional volt-ohm-milliampere meter into a sensitive field-strength meter which will give accurate measurements of actual radiated power on any frequency up to thousands of megacycles. The heart of the adaptor is a radar crystal used as a detector. The mechanical design of the adaptor connects the crystal across the meter input. The length of the leads from the meter determines the resonant frequency of the detector.

—Radio and Television News (U.S.A.), Aug., 1953, p. 59.

MATHEMATICS:

Equivalent transistor circuits and equations: relations between transistor parameters, circuit elements, and performance are derived using T equivalent and applying Kirchoff's mesh equations. Input and output resistances are explained and expressions for voltage gains derived.

—Electronics (U.S.A.), September, 1953, p. 156.

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Most provincial express trains run daily from mid-December to mid-January.

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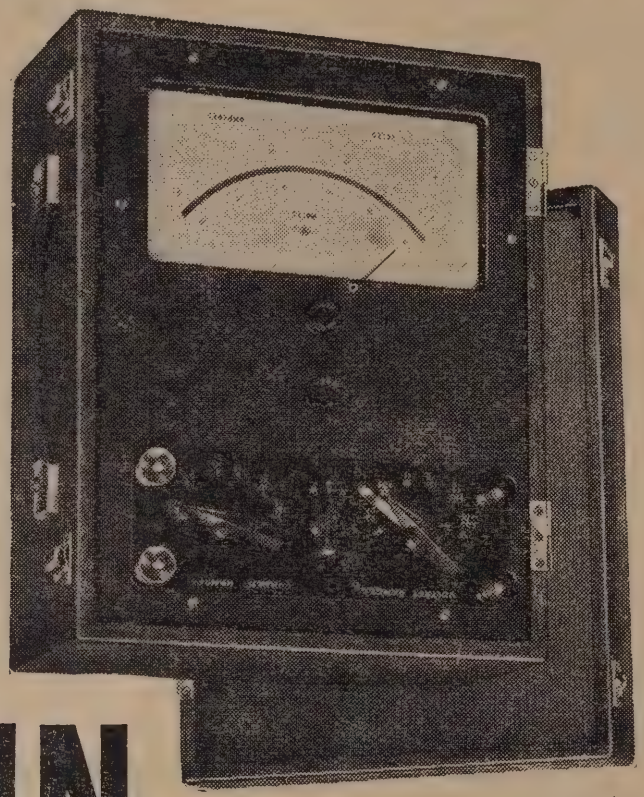

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RADIO ROUNDABOUT

MARCONI AND A.W.A. EXHIBITS AT THE S.B.A.C. SHOW, FARNBOROUGH

At the static exhibition of the Society of British Aircraft Constructors at Farnborough, Britain, in September of this year, Marconi's Wireless Telegraph Co. Ltd., and its Australian associate, Amalgamated Wireless (Australasia) Ltd., shared adjoining stands. This produced a more representative display of aeronautical equipment, allowing for equal emphasis on air-borne and ground radio and navigational aids.

Centred round a half-scale model of the radio installation inside a typical airliner, the air-borne equipment comprised remotely controlled multi-channel V.H.F. transmitter/receivers (type AD.115), an H.F./M.F. high discrimination receiver (AD.94), an intercommunication station box (AD.401), 120-watt H.F. transmitters (AD.107B), pre-tuned H.F. receivers (AD.114), and automatic radio compasses (AD.7092A). In addition, each of these units was displayed separately in full scale, two of them (AD. 7092A and AD.401) operating as if in use inside an aircraft.

The ground equipment focused on a Marconi-I.A.L. control desk for use by air traffic controllers at airports. This 10 ft. wide desk in modern metal casing was designed so that the controller could easily reach and see all his control and information devices—e.g., radio telephone communication between ground and air, barometer, wind speed and direction indicators, maps, airport telephones, and remote bearing indicators of the V.H.F. direction finders (AD.200).

In the main, Amalgamated Wireless exhibits were also divided into the same two categories: air and ground radio. In the air-borne section there was an 8-channel H.F. transmitter/receiver (HAC-1) and a 120-channel crystal locked receiver (HAC-2), also a lightweight three-channel V.H.F. transmitter/receiver (VAC-1B), which, because of its compactness and weight of less than 10 lb., is ideal for installation in small aircraft.

In addition, the exhibits included a double-pulse system of air-borne distance measuring equipment (VAN-3) operating on the 200 mc/sec. band, and an air-borne intercommunication amplifier unit (ACA-1C). A further item of interest was a suppressed aerial (VJN-2) for use with 75 mc/sec. marker beacon receivers.

Of special interest for ground use was an H.F. pack set (AF150), which was primarily designed for the Services, and the associated special aerial coupling unit which enables a very high performance to be obtained. There was also an H.F. receiver (C-55184) with "Codan," an anti-noise device, which was shown in operation.

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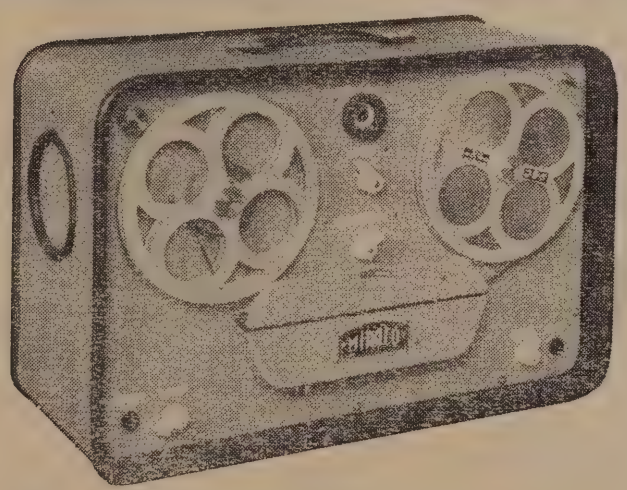
ARCOLECTRIC will make it
New Zealand Agents
GREEN & COOPER LTD. WELLINGTON.



The Marconi REPROVOX Tape Recorder

In its grey crackle finish steel carrying case with black protective beading, the Marconi Reprovox Tape Recorder, shortly available from stock in Wellington, is distinctive for many new features:

Twin Channel Recording.

Fast Re-wind Time.

Operates with standard magnetic recording tape. Can take reels up to 1200 ft.

Tape Protecting Mechanism prevents tape from spilling.

Safe and simple operation with 6 controls. Built-in amplifiers.

Power Supply: 230 volts A.C. 50 cycles. Consumption: 75 watts (approx.).

Input impedances: 15 ohms, 10,000 ohms.

Three speeds are available:—

Tape Speeds	Playing Time	Frequency Range
3¾ in. per sec.	2 hours	60 to 5,000 c/s.
7½ in. per sec.	1 hour	60 to 8,000 c/s.
15 in. per sec.	½ hour	60 to 10,000 c/s.

Width, 20 in.; depth, 8½ in.; height, 12¼ in.; weight, 42 lb.

New Zealand Representatives:

AMALGAMATED WIRELESS (A/SIA) LTD.

P.O. BOX 830, WELLINGTON P.O. BOX 1363, AUCKLAND

WARTIME INVENTION RECOGNIZED CROWN PAYS £20,000

Pye Ltd., Cambridge, England, has been paid £20,000 by the Crown in recognition of the original design and development work carried out by the company during the war on the radio-operated or proximity fuse.

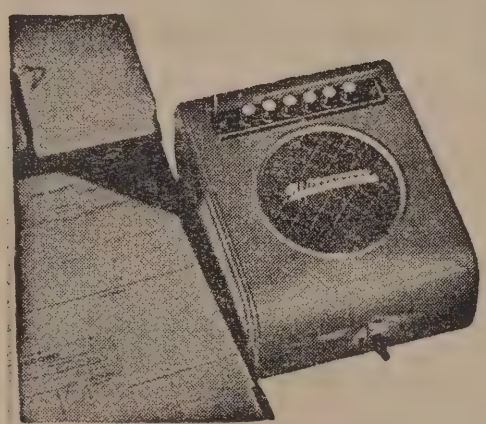
In May, 1940, the Pye Company commenced work, on its own initiative, on the design of a radio valve that would withstand the shock of being fired from an anti-aircraft gun. The magnitude of this problem can be seen from the fact that the valve had to withstand a setback force of 30,000 g. ("g" being the measure of the force of gravity) and to withstand a rotation of 20,000 revolutions per minute. The first successful valves were tested in July, 1940, and, as a result of this, work was commenced on a radio-operated fuse which was the forerunner of the modern proximity fuse. The work was then continued under a Government contract and later still was handed over to the Americans. The fact that the design actually originated in Britain is not generally known, and is now confirmed by the British Government's grant to the Pye Company. Whereas a percussion fuse explodes a shell on impact with a target, and a time fuse can be set to explode at a pre-determined time after leaving the gun, the proximity fuse explodes the shell in which it is carried as soon as the target is within the shell's lethal range. The proximity fuse was one of the vital secret weapons used by British and Allied anti-aircraft batteries in the latter years of World War II, and was chiefly responsible for the British victory over Germany's V2 "buzz-bomb" during the attacks on London.

FIRST COMPLETE MARCONI TV STUDIO FOR B.B.C.

Studio E at Lime Grove, London, is the first television studio fitted with vision equipment designed for studio use by Marconi's Wireless Telegraph Co. Ltd. for the B.B.C. Equipment for the studio has been designed to meet the B.B.C. specification.

The studio has a production suite including several separate control rooms for both sound and vision. During a programme, the producer and his assistants work at the controls of the large vision mixer in the vision control room, with a view overlooking the studio, while the actual mixer, together with camera control units and distribution amplifiers, is in the nearby apparatus room.

The studio has been provided with six Marconi image orthicon cameras. Four of these are for normal use during programmes, a fifth is kept as an operational spare for immediate use if required, while the sixth is for maintenance. This is not assembled, but remains a pool for spare parts.



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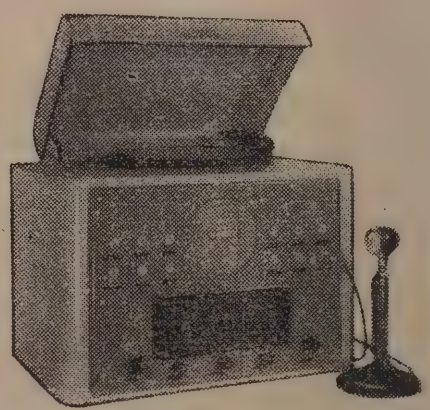

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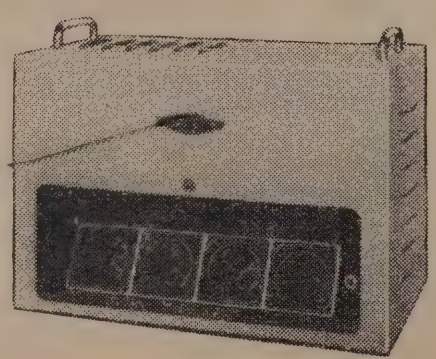
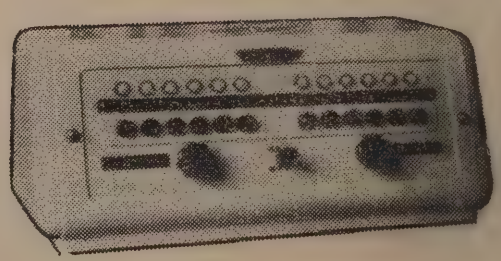


PUBLIC ADDRESS EQUIPMENT



CONTROL EQUIPMENT

PHONE 30-195 (3 lines) BOX 1166

RADIO (1936) LIMITED

QUAY STREET AUCKLAND

The mixer control panel has been designed as part of a large desk in front of which are the production and preview monitor screens. The remainder of the mixer consists of rack-mounted units which are situated in the apparatus room.

The mixer has 16 inputs—i.e., 16 "services" which can be selected and prepared for transmission. These include the signals from any one of the cameras in use, telecine pictures, different effects, and a series of test signals. The controls take any selected input, prepare it—cut, mix, or fade, etc.—for transmission, or feed it to any of eight monitor screens; later, the existing monitors will be replaced by those of a particularly high quality—14 in. for production purposes and 17 in. for transmission checking.

From the mixer and amplifiers, the signals are next passed to Lime Grove's central control room on one of duplicated output channels, and then sent for transmission over the air.

At central control's own apparatus room, Marconi's have installed two synchronizing generators which synchronize all pulses from Lime Grove, and five test signal generators. Eventually, they will also supply six monscope cameras for the transmission of captions and test cards.

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These are available to hold 12 issues—price 5s. 6d.

Missing and Stolen Radios

Criminal Investigation Branch, Auckland

Pacemaker 6-valve portable A.C. and battery model, serial No. 18360; maroon-coloured plastic case, white plastic handle.

Skyscraper, portable electric and battery broadcast model, serial No. 133346; brown plastic case 14 in. by 9 in. by 6 in.; two brown tuning knobs at front, white circular dial; removable back; white plastic carrying handle on top.

Publications Received

Philips Sight and Sound: A Guide to Television (Philips Electrical Industries of N.Z. Ltd., Wellington).

"Student Engineer" (Engineering Society, National School of Engineering, Canterbury University College).

Enterprise No. 25, September, 1953 (Cory-Wright & Salmon Ltd., Wellington).

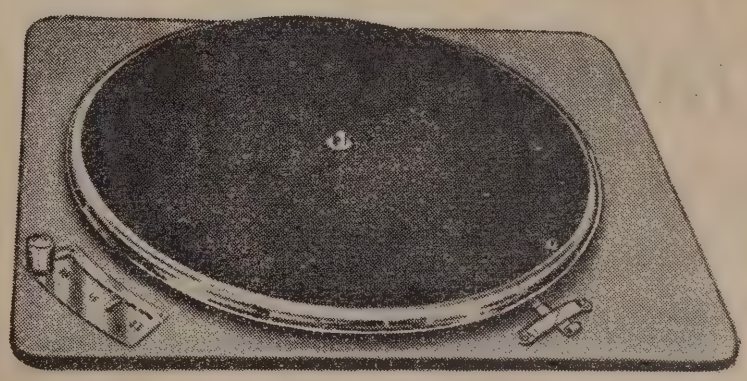
Break-In, Vol. XXVI, No. 10, October, 1953.

Wireless & Electrical Trader, Vol. 91, No. 1193, August 29, 1953.

Machinery Lloyd, Vol. XXV, No. 18, 29th August, 1953.

GRAWOR

Universal Three-Speed Motor (51G)



33⅓, 45, and 78 revs. per minute. Alternating current 110/220 volts, suitable for mounting in gramophones and tape recorders.

Like the modern car, the GRAWOR motor has three variable speeds to obtain 33⅓, 45, or 78 revolutions per minute. Each of these speeds is controlled by an adjustable regulating governor.

Once the controls have been adjusted, the motor is running at a constant number of revolutions, and is perfectly silent, because a milling process combined with efficient balancing of the regulating governor excludes any variation even at low speeds. The regulating governor has the special advantage in that, at top speed, the super-dimensional weights press against the cone of the brake pulley.

At 78 r.p.m. the motor has an effective output of 900 cm. per gramme—Owing to the very rigid iron sheet casing it withstands the utmost stress.—The two driving shafts are most suitable for mounting in tape recorders.—The motor has a power consumption of approximately 20 watts and, under a permanent load, becomes only a little warm, as the regulating governor acts as a fan.

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Nixa LP News (N.Z. Music Supplies, Wellington).
Castleco Switches—Castelco (G.B.) Ltd., Old Woking, Surrey, England (His Master's Voice (N.Z.) Ltd.).
Television Fundamentals, by Kenneth Fowler and Harold B. Lippert (McGraw-Hill Book Co. Inc.; for review).
Electrical Industries Export, Vol. 53, No. 9, September, 1953 (Continental & Overseas Organization Ltd., London).
Modern Manufacturing, Vol. 5, No. 1, September, 1953.
Wireless World, Vol. LIX, No. 9, September, 1953.
"Radiotronics," Vol. 18, No. 10, October, 1953 (Amalgamated Wireless Valve Co. Pty. Ltd., Sydney).
"Radio-Electronics," Vol. XXIV, No. 9, September, 1953.
"Electronic Engineering," Vol. XXV, No. 307, September. 1953.
"Service," Vol. 22, No. 8, August, 1953.
N.Z. Science Review, Vol. 11, Nos. 9 and 10.
The New Zealand Manufacturer, Vol. 5, No. 3, September, 1953.
"das elektron," Jahrgang 1953.
Mullard Technical Communications (Overseas Edition, Vol. 1, No. 4, Mullard Ltd. (C. & A. Odlin Timber and Hardware Co. Ltd., Wellington).
"Wireless World" Guide to Broadcasting Stations, 7th Edition (Iliffe & Sons Ltd., London, England).
Continuous Bar Cropping . . . . Right Where it's Wanted"; F. J. Edwards Ltd., London (Levin & Co. Ltd., Wellington).
"Radio Electronica," August, 1953.
N.Z. Electrical Journal, Vol. 26, No. 10, October, 1953.
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La Radio-Revue, Vol. 5, No. 9, September, 1953.
"Aerial," July, 1953 (Amalgamated Wireless (Australasia) Ltd.).
4 New Stars in the Pope Sky: D-96 Battery Tubes (Swan Electric Co. Ltd.).
Philips Technical Review, Vol. 14, Nos. 6 and 7, December, 1952, and January, 1953: N.V. Philips Gloeilampenfabrieken, Eindhoven, Netherlands (Philips Electrical Industries of N.Z. Ltd.).

CLASSIFIED ADVERTISEMENTS

FOR SALE.—"R. & E" Prototype Allwave Tuner, described August, 1951; unused; £20. Also Pickering Preamplifier 130H. and Pickering Record Compensator 132 E., both unused; £20. Reply, "Audio," c/o "Radio and Electronics."

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FOR SALE.—Transcription Turntable, Byer 16 in.; 33⅓ and 78 r.p.m.; perfect condition; £60. Call or phone. Electro-Technical Industries, Dixon Building, Wellington. Phone 53-394.

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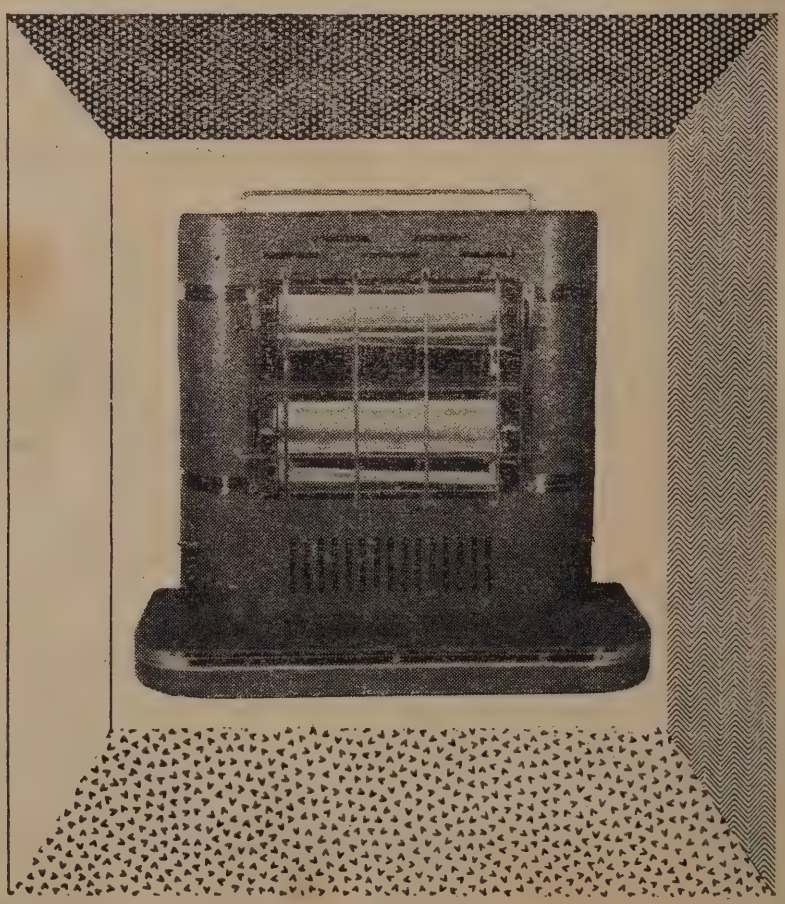

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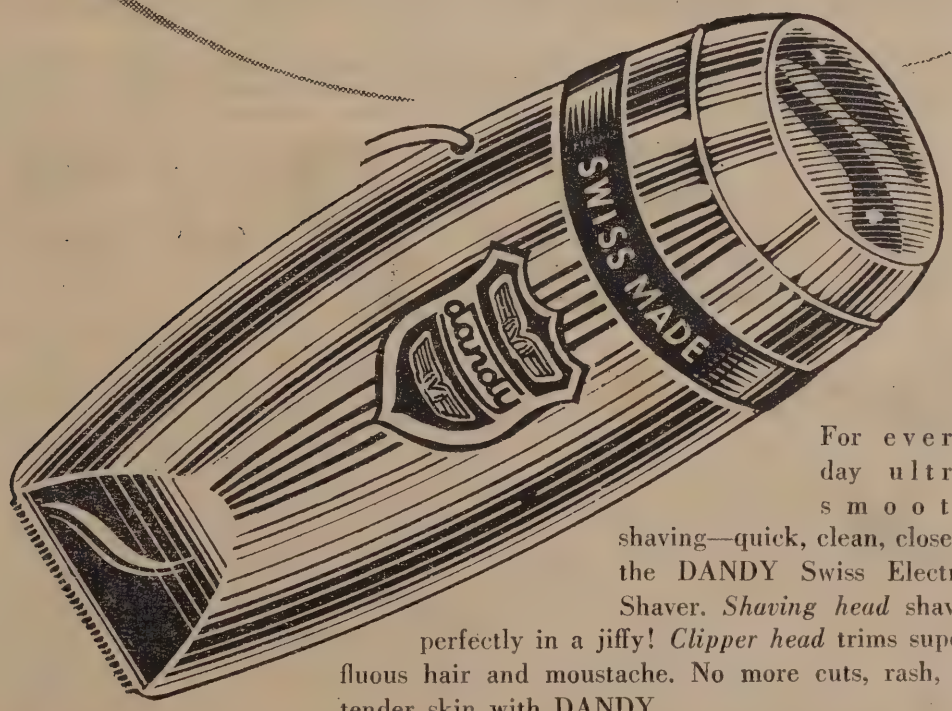

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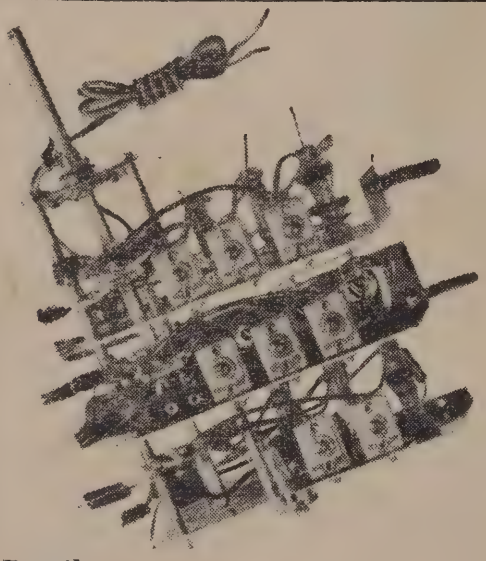

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Accurately aligned to dial calibration.
You merely add I.F. and audio stages.
The spread on shortwave makes shortwave tuning easier than broadcast.

IDEAL as base for really high-quality RADIOS, TUNERS, RADIOGRAMS, etc.

Details:

49, 31, 25, and 19-metre bands, plus broadcast. Extremely accurate calibration and frequency stability. Split stator tuning condenser and temperature compensated oscillator. Only three simple adjustments necessary to completely align each bandspread band. Handsome floodlit dial scale. Effortless tuning from high ratio 24/1, ball-bearing spin wheel drive. Gang isolated from mechanical and electrical vibration and noise. Bandspread calibration linear and marked in 100 k/c divisions and fractions thereof. A 0-100 logging scale also provided. "BAND," "TONE & GRAM." indicators fitted. Special A.V.C. system provides shorter time constant on shortwave to rapidly compensate for fading signal. Polystyrene low-loss adjustable slug coils throughout. Full instructions and suggested I.F. and audio circuits.

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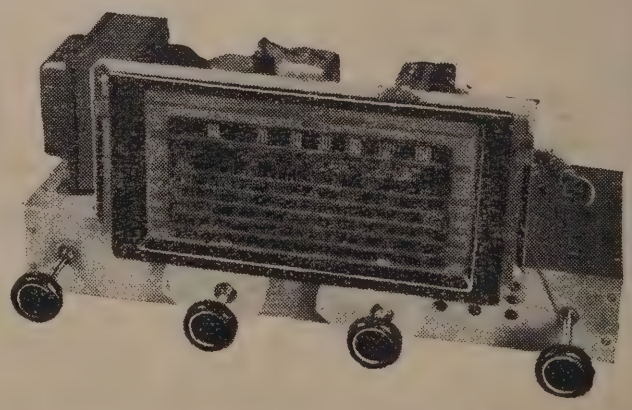

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Proceedings of the New Zealand Electronics Institute Incorporated.

Christchurch Branch

After enjoying an excellent lecture on "Transistors" given in September by Mr. R. A. Clements, M.Sc., Instructor at the Electrical and Wireless School, R.N.Z.A.F., Wigram, members of the Christchurch branch were eagerly looking forward to Mr. Clements's second lecture on "Electronic Counters," to be given at the October meeting.

Since the commencement of its 1953 programme, Christchurch branch has enjoyed increased attendances at its monthly meetings, a sure indication of the appreciation of the benefits of membership.

The October meeting of the Wellington branch took the form of a demonstration of the technical equipment in current use in the New Zealand Broadcasting Service, and was held in the studios of 2YA on Wednesday, 28th October. Members who had not seen the inside of a broadcasting studio for several years were astonished at the changes that had been made in such a relatively short time. Particularly interesting were the facilities for recording, which now include high-fidelity tape machines as well as the latest disc recorders. Of particular interest, too, was the record-playing equipment, which is now designed to handle L/P discs of all types as well as 78 r.p.m. ones.

On the Wellington Branch's programme are a lecture describing Muirhead picture-telegraph equipment, and a members' discussion evening of the type that has proved very popular in the past. In these evenings, three or four topics of general interest are introduced briefly by selected members, this introduction serving as the basis of a round-table discussion. Many knotty problems come up and are thrashed out with considerable enthusiasm, and it is felt that discussions of this nature can often be of more use and interest than formal lectures.

The Wellington Branch Management Committee is about to carry out a personal canvass of the Branch members, asking them for any ideas they may have for lectures, visits to places of technical interest, and other activities which they feel the Branch might well include in its programme. Any members who have not yet been contacted are invited to send in their suggestions to the Hon. Branch Secretary, Mr. W. E. H. Docherty, 135 Messines Road, Wellington, W.3.

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Plays Standard and Long-Playing Records
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* Featherweight Tone Arm with crystal pick-up ensure minimum wear on records.

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Harmonic Signal Generator

(Continued from page 7.)

that is a multiple of 100 kc. For example, 3ZB is on 1,100 kc/sec., and 2YX is on 1,400 kc/sec. In addition to these, we have our already calibrated 1,000 kc. oscillator. These give us at least two additional check points. There are others, too, and as long as they can be identified by dial sign, they can be used as standard frequencies. Now, if we set the 100 kc. oscillator to give zero beat on 3ZB, we know that 1,100 is now a harmonic of the oscillator. But if at the same time the oscillator produces a signal in precisely the same spot on the dial as does the 1,000 kc. oscillator, then 1,000 kc/sec. must also be a harmonic of the oscillator. If both are harmonics, then the oscillator **must** be on 100 kc.

CONCLUSION

In next month's issue of "Radio and Electronics," we will have an article showing how to use a fixed-frequency signal generator like this one to align radio receivers. The procedure is very similar to that of using a variable-frequency oscillator, and readers will not find it at all difficult to carry out. In the meantime, we would urge all those who have been troubled by the lack of a signal-generator to set to and build these inexpensive but exceedingly useful units. We are sure they will find the time and effort very well repaid.

Philips Experimenter

(Continued from page 24.)

of 29 68 = 97 volts, which is quite close enough to the projected figure. From the above calculation, it can be seen that the cathode and grid leak biases act quite independently, and can be calculated just as if the other did not exist, provided that it is decided for a start how many volts will be obtained by one or the other, this decision fixing the amount that must be provided by the remaining method. Incidentally, there is some virtue in V.H.F. circuits in using a combination of fixed and cathode bias, since this lightens the driving requirements to the extent of the D.C. power dissipated in the grid leak if one is used. In fact, if the driving power is a bit marginal, then this may be the only means of getting both the required bias and grid current.

A Step Forward

(Continued from page 2.)

is a 50-kilowatt transmitter employing frequency-shift keying.

Not the least interesting part of the station is the almost staggering array of aerials. These are of two types—rhombics and curtain arrays—and are sufficiently numerous to ensure that all useful propagation paths can be used, as conditions require. In the design of the aerial systems, account has been taken of the fact—discovered and investigated by New Zealand engineers—that radio energy does not follow the expected great-circle routes between U..K and New Zealand. Space prevents more detailed description here, but we congratulate all those who have helped establish this, the longest R/T circuit in the world. It is one which will prove of inestimable value to New Zealand and Empire communications.

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OSCILLATOR COILS:
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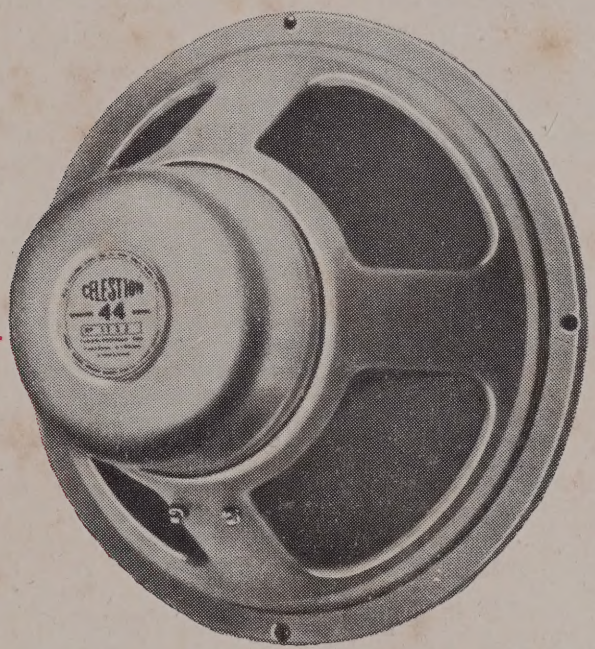

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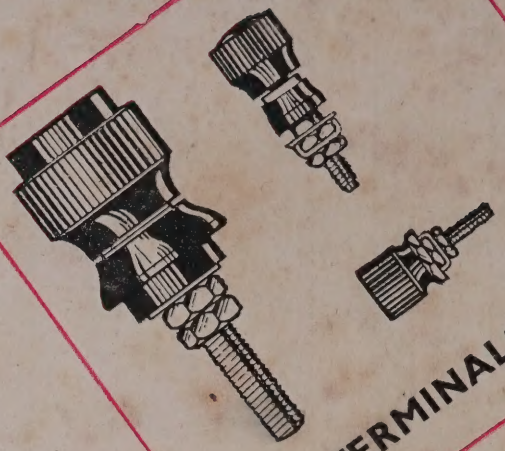
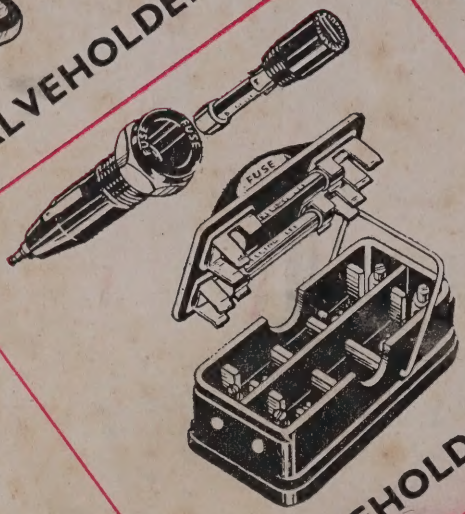


TERMINALS



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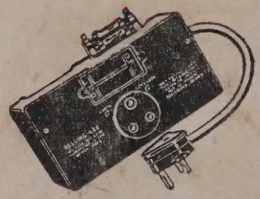

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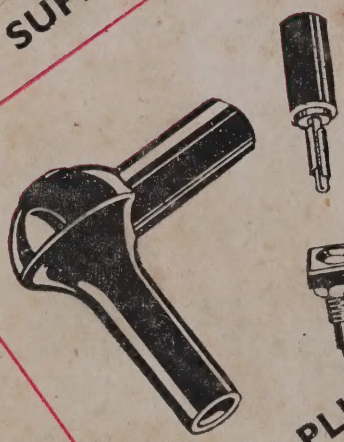
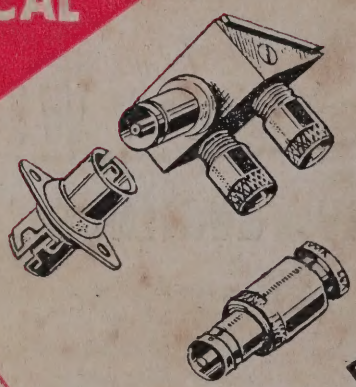
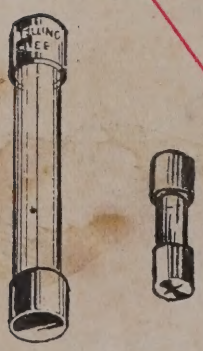
RADIO AND ELECTRICAL



PLUGS AND SOCKETS



COAXIAL PLUGS AND SOCKETS



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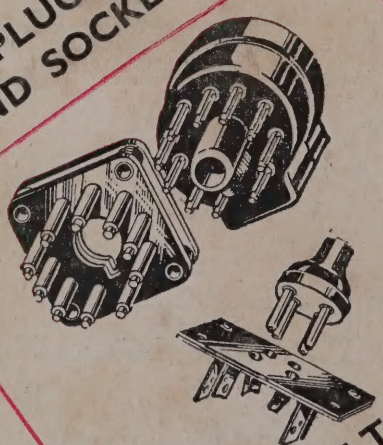

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